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DISCOVERY

A Monthly Popular Journal of Knowledge

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IN THIS ISSUE

Ancient India in Indo-China

By Dr. H. G. Quaritch Wales

◆

Stereochemistry

By Dr. Peter Maitland

◆

Measuring Dust : : By Dr. S. C. Blacktin

◆

The Story of Stone Money — Rail Transport Development, 1936
The Hebrew University in Jerusalem — A Forgotten Harbour

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(*Continued on page xcix*)

DISCOVERY

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Notes of the Month.

Medical science and the University of Oxford are to be congratulated on the receipt of a generous benefaction at the hands of their trusted friend, Lord Nuffield. Sums amounting to about £1¼ millions have been offered by him to the University (and gladly accepted) with the object of establishing a post-graduate medical school, vastly widening the scope of the existing Nuffield Institute for Medical Research. The terms of the gift are generously flexible, but the primary object is the establishment of senior posts to be held by full-time University professors, under whose direction would be a body of clinical assistants. These posts would be open to any qualified practitioner, whether a graduate of Oxford or not.

* * * *

At the same time it is intended that the co-operation of the authorities of hospitals in the neighbourhood shall provide clinical material for the purposes of medical research, while opportunity would be given for admitting to pay beds a limited number of patients who can afford fees for treatment. The fund is to be administered by trustees appointed by Lord Nuffield (and on his death by the Chancellor of the University), by the University, and by the governing bodies of the Radcliffe Infirmary and the Wingfield-Morris Orthopædic Hospital (the two Oxford hospitals with which Lord Nuffield is closely associated). A further bequest of £100,000 has the object of ensuring that the other scientific departments of the University, upon which the new scheme will make considerable demands, shall not be prevented by straitened finances from providing essential services.

* * * *

The Department of the Interior at Ottawa has been advised by radio-telegraphy that the Canadian Government's 1936 expedition to posts in the Eastern Arctic, which started on July 14th, has practically completed the southern part of the patrol, including the circuit of Hudson Bay. The R.M.S. *Nascopie* was then steaming eastward in Hudson Strait, and on arriving at the eastern entrance would turn northward for the voyage to the more northerly posts on Baffin, Devon, and Ellesmere islands. The latest report from the officer in charge of the expedition, stated that the ship had reached the south coast of Baffin island and was to make for the northern end of that island. The passage through the northern ice-fields to Pond Inlet, Dundas Harbour, and Craig Harbour, the latter within 800 miles of the North Pole, is the most trying part of the annual patrol. However, the favourable weather conditions experienced during the earlier part of the voyage are looked upon as auguring well for the remainder of the patrol. Readers of Discovery will have obtained, from Mr. Goulding Smith's article in our September number, a good idea of the scenery and conditions likely to be met with.

* * * *

Considerable publicity has been given to the news that a figure of the Roman she-wolf is being erected in Addis Ababa. Less reference, however, has been made to the copy of another famous work of Italian sculpture which is likewise to have a home in Abyssinia. This is the *Volto Santo*, the famous cedar-wood crucifix which is preserved in the Cathedral of Lucca, supposed to have been begun by Nicodemus and miraculously completed after the Crucifixion. It was already well known in the 11th century and "*per vultum de Lucca*" is said to have been a favourite oath of William Rufus. The mediæval merchants of Lucca, according to the Florence correspondent of *The Times*, used to carry the cult and

veneration of the Holy Face with them on their journeys abroad, so that the gift of a copy of it by the soldiers of Lucca to a church in Abyssinia keeps up the old tradition.

* * * *

The Jubilee Exhibition of the British School of Archæology at Athens, which is occupying four rooms of the Royal Academy at Burlington House, is an extremely interesting record of the fifty years' work of this School. So used are we nowadays to talk of large government subsidies for this, that, and the other, that we are apt to take it for granted that a " British School " abroad is little more than a super-genteel branch of the Civil Service. Nothing, in this case, could be farther from the truth, as apart from a small government subsidy of £500 per annum the School is entirely dependent on the wise charity of individuals, universities, and other corporate bodies. The present exhibition is a most justifiable effort to attract public attention to the work that has been, and is being done.

* * * *

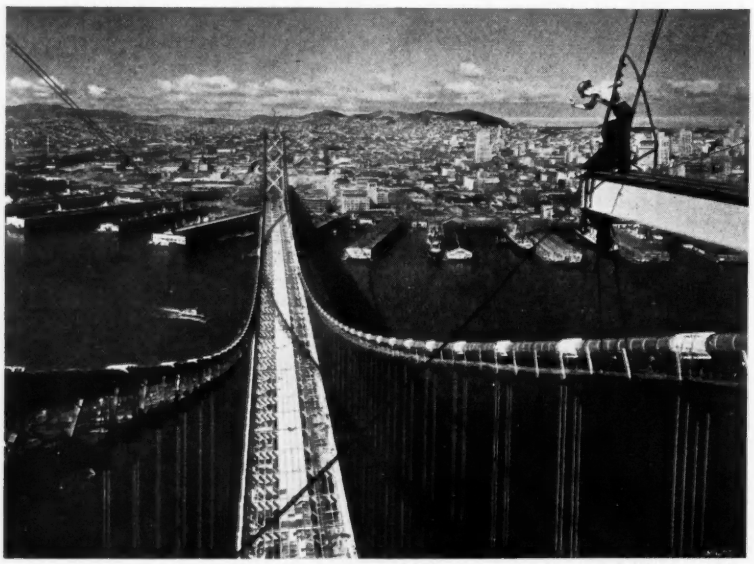
Space does not allow us to give a detailed description of the exhibits: a very excellent catalogue does that, for the price of one shilling. Here it is enough to say that the four rooms are devoted, the first to illustrations of Minoan culture, with special relation to the discoveries at Knossos in Crete, arranged by Sir Arthur Evans, the greatest living authority on the subject; the second to the work of the School in various sites, notably at Mycenæ, Sparta, Melos, Palaikastro (Crete), and Perachora; the third to the work of individual students of the School; and the fourth to the special Byzantine research studies undertaken by the School. Of special interest are the exhibits showing the inter-relation of the Minoan and Eastern civilisations, brought lately into prominence by Sir Leonard Woolley's Syrian discoveries; the original leaden votive offerings from the Orthia sanctuary at Sparta; and the fine series of photographs throughout.

* * * *

When the two volumes of *The Letters of Gertrude Bell* were published in 1927, there was one conspicuous gap. Lady Bell, the editor of the letters, had regretfully to explain that two series could not be discovered. The first was written during Gertrude Bell's visit to Rumania when she was twenty-two years of age, and the second during her visit to Persia when she was twenty-three. These letters have now, by great good fortune, been found by Lady Richmond, who has collected them, together with others written in her step-sister's youth, in a volume which will shortly be published by Ernest Benn, Limited. The Rumanian and Persian Letters are of special interest as containing Gertrude Bell's first impressions of the Near and Middle East, which were to be the background of her remarkable career. The title given to the book is *The Earlier Letters of Gertrude Bell.*

* * * *

The San Francisco - Oakland Bridge, 8¼ miles long, will be ready for motor traffic in the early days of November according to Mr. C. H. Purcell, the chief engineer. The photograph reproduced herewith is taken from the top of the midstream tower, showing one of the suspension spans over the West Bay. In the East Bay crossing there is a 1,400-foot cantilever span of two decks; the upper deck is 58 ft. wide and has six motor-car traffic lanes. The lower deck will accommodate three lanes of traffic and two inter-urban electric railway tracks. There is no provision for pedestrians. The lateral sway at the extreme height of the bridge towers is 7 ft. during gales, and has caused much illness resembling seasickness amongst the working crews. The loss of life through falls has been heavy.



[*Photo by courtesy of California Toll Bridge Authority.*

A suspension span of the San Francisco-Oakland Bridge.

Ancient India in Indo-China

By H. G. Quaritch Wales

Field Director of the Greater-Indian Research Committee.

Discoveries of first-rate importance concerning ancient Indian settlements in Indo-China have been made this year by the research expedition under Dr. Quaritch Wales. We are fortunate in being able to present our readers with his account of the work done at Takuapa and Sri Deva, which gives promise of further important finds in the future.

THE Greater-Indian Research Committee was founded in 1934, under the chairmanship of Sir Francis Younghusband, with the object of throwing new light on Indian cultural and colonial expansion throughout South-Eastern Asia, by means of practical archæological exploration in the field. So far, two expeditions have been carried out under the auspices of the Committee, and a large amount of new information has been obtained as a result of the examination and excavation of ancient Indian sites in Siam and the Malay Peninsula.

The first expedition began work at Takuapa, on the west coast of peninsular Siam, a place which, from its possession of an excellent natural harbour, and its being the first point of land which the Indian colonists would have reached as they sailed across the Indian Ocean, and through the Ten Degree Channel between the Andaman and Nicobar Islands, was obviously a place of great historical possibilities. Moreover, it had been identified by scholars as the Takola Mart of the Alexandrine geographer Ptolemy, and many years ago a mining engineer had reported the existence of ancient remains in the vicinity which had never been properly investigated.

Adventurous Princes

References in early Indian literature show that the Indians, most probably coming from the region between the Kistna and Godaveri rivers, began to make sea voyages to the "Land of Gold" as early as 400 B.C., though there is no evidence that they made actual settlements before the first centuries of the Christian era. They came at first as traders, and only later began to make settlements in the little river valleys of the Malay Peninsula, where they set to work to mine the gold and tin. Adventurous princes, exiled from their homeland by the troubles which so often upset the life of Indian royal courts, sometimes came with them, and became rulers of the new settlements, often wandering as far afield as the coasts of Java and Indo-China in the quest for a new home. Thus by the 4th century A.D. a number of petty Indian states had sprung up in the Peninsula, and the foundations had been laid of the great Indianised Empire of Fu-nan in southern Indo-China.

The natural harbour of Takuapa, where we began our investigations, is formed by a number of islands which protect the mouth of the river from the breakers of the Indian Ocean, and provide a wide expanse of calm water between themselves and the mainland. Tin mining is still carried on in the valley of this river, and a number of ancient shaft workings have been found; but on the whole the mainland still consists of undeveloped jungle-clad foothills gradually passing into the mountain ranges of the interior, and providing scenery of great beauty, quite characteristic of the unspoilt and little known west coast of Siam. The site of the ancient settlement is on the southern island, which is low and sandy, and faces the main mouth of the Takuapa river. Just opposite the settlement, on the mainland, there is a small hill, covered with jungle, on the summit of which there are the remains of a small Indian shrine, which must have dominated the harbour. This shrine formerly contained a fine life-size stone image of Vishnu, now removed to the Bangkok Museum. It dates probably from the 6th century A.D., and is reminiscent of the famous Gupta art of India.

Pottery and Gold Dust

The southern island is covered with thin jungle scrub, with the exception of the site of the ancient settlement, which was found to be an open grassy space measuring about 375 yards by 225 yards, and separated from the waters of the estuary by a narrow belt of mangrove swamp of recent origin. Near the northern and southern ends of this area two little streams, one of which appeared to have been hollowed out to form an artificial tank, flowed into the estuary. The whole area was littered with potsherds, amongst which, in addition to much rough domestic pottery which was probably made by the Indian colonists, we found Chinese glazed ware dating from the period of the Six Dynasties (A.D. 220-589); also fragments of a widely travelled class of Chinese ware, previously found at Brahminabad in Sind, and in the rubbish heaps of Cairo, dating probably from the 8th or 9th century A.D. There was also a type of blue-glazed Islamic pottery, originating from Southern Persia, and dating also from the 8th or 9th century. It had no doubt been brought by Arab

traders. Gold dust has also been found on the site, which, since it is not of local origin, was probably used by the merchants as a medium of exchange. On the evidence of the pottery it thus appears that the settlement flourished from about the 4th to the 8th or 9th century A.D., and, though primarily Indian, it was frequented by Chinese and Arab merchants.

The fact that the settlement was Indian was proved when we excavated three mounds on the western side of the area. Here the foundations of an Indian brick temple paved with schist slabs were brought to light, but apart from a few Indian beads of about the 7th century A.D., no finds of interest were made in connection with it. This was disappointing, as it appeared that at some time the temple must have been looted. However, our disappointment was short-lived. We were shown a place about twelve miles up the Takuapa river, just above its junction with a tributary, where, lying near the river bank, were three large stone Hindu images, two male and one female. They presented a most curious sight, for they had at some period been placed against a sapling which in course of time had grown up and almost engulfed them. The smaller male figure was certainly a representation of Siva, as one could tell from the head-dress, and from the presence of a sculptured skull pendent from the ear. They were all of purely South Indian workmanship and could be dated from the 7th or 8th century. But the most interesting point was that a number of circumstances enabled me to prove that these images had been transported up the river from the temple on the island site. There was, for example, no trace of a temple at the point where the images were found, and several slabs associated with the images were of exactly the same type as those which had been found on the island and nowhere else. Moreover, on one of these slabs was an inscription in 8th century Tamil which spoke of the foundation of a tank by a benefactor who had placed it in the charge of a well-known guild of Indian merchants, and of the soldiers and the cultivators, just the three classes of Indian colonists that one might expect to find at any settlement. One would not, however, expect to find a guild of Indian merchants established so far from the coast, nor would one expect anyone to build a tank at the junction of two large rivers! On the other hand, the large population on the sandy island would obviously have required some means of water storage, and in fact the remains of a tank had actually been discovered on the island. But the reason why the heavy images and the inscription were carried so many miles up the Takuapa river was a mystery which was not explained until our researches in the Peninsula had progressed considerably further.

When the Indian colonists wanted to expand beyond the somewhat narrow quarters of the Peninsula west coast valleys, they had to brave the pirate-ridden waters of the Straits of Malacca, unless they could find some comparatively safe overland route to the eastern coast of the Peninsula. In this matter the Takuapa settlers were particularly favoured, because it is only in this latitude that two rivers run approximately east and west respectively from the watershed, forming an almost

Left: Indian brick temple at Sri Deva (5-6th century), probably the earliest known Hindu temple in Indo-China, at the foundation of Khmer art. Centre: 8th century temple of Indian colonial architecture at Chaiya (Malay Peninsula). Right: Khmer temple of the 11th century re-occupation at Sri Deva.

continuous waterway. Moreover, Takuapa harbour, the finest anchorage on the west coast, was opposite the best harbour on the east coast, the Bay of Bandon, sheltered by two large islands from the north-east monsoon. This harbour provided a splendid base for further adventuring across the seas. In early times the crossing of the route presented none of the difficulties that it does to-day, because the rivers were much deeper before they had been silted up by Chinese miners.

Three days march from Takuapa brought us over the divide to where we were able to obtain small boats with which to make the journey, rendered laborious by the presence of numerous shallows, to the fertile lands around the Bay of Bandon. But the scenery, with its isolated peaks or limestone ranges, was often very beautiful. The first ancient site visited by us in this eastern region was the City of the Lake, buried deep in thorn jungle, through which we cut a path to the central shrine, where ancient Indian images of great interest were found. We then carried out excavations at the ancient city of Chaiya, situated north of the Bay of Bandon, which, as we can tell from inscriptions, seems to have been the capital of a great Indianised empire extending over the Malay Peninsula and the islands of Java and Sumatra from the 8th to the 12th century A.D.

Above: Stone figure of the 5-6th century at Sri Deva, probably representing Vishnu. Left: Hindu stone images, partially engulfed by tree-trunks, on the bank of the Takuapa river.

The general results of our investigation along this overland route show the existence of a belt of ancient Indian remains stretching across the Peninsula in this latitude, but exhibiting an evolution from purely Indian sculptural and architectural forms on the west coast to more local colonial types at the sites of great cities near the east coast. We were able to show that between the 4th and 8th centuries A.D. several waves of Indian colonists, each bringing the Indian art and religion of the period, had spread across the Peninsula by this route, in order to avoid the dangers of the all-sea route to the East. It was no doubt in the course of this movement across the Peninsula to the more fertile lands and flourishing cities of the east coast that the stone images from Takuapa had been carried up the river. But the shallowing of the river above its junction with the

tributary had evidently obliged the boatmen to drop the images on the bank.

In early times the Malay Peninsula was broken up into a number of petty Indian states, the most important, that through which ran the overland route, being known to the Chinese as P'an-p'an. Their records tell us that about the end of the 4th century A.D. a Brahman from India named Kaundinya crossed the overland route and made his way to Fu-nan and changed all the rules there according to the customs of India. His descendants built up a great empire there, the vassal states of which stretched as far as Burma. But in 550 A.D. the rise of the Khmers in Cambodia brought about the downfall of the Fu-nan empire and, though the location of its capital is known, no architectural or artistic remains have survived from this period, because they were all ground to powder in the process of the growth and evolution of Khmer culture which took place on the same territory. But some fragmentary sculptures and an inscription of the early 6th century, brought to Bangkok by natives some years ago from the remote Pasak valley of eastern Central Siam, suggested that in that secluded locality there might be the ruins of a city of the Fu-nan period, possibly the capital of some vassal state, which would throw light upon this early period of Indian colonisation. The exploration of this remote and ancient city, known to local peasants as Sri Deva, formed the object of our second expedition.

From the Siamese northern railway at Lopburi a rather difficult journey of some days with bullock carts, across the thin jungle-covered plain of eastern Central Siam and thence over the Pechabun hills, brought us to the Pasak valley. The city itself was found to lie in thin deciduous jungle a few miles from the unnavigable Pasak river. It was typically Indian in plan, but quite unlike any other city in Indo-China. It consisted of a main city, a mile square, on to the eastern side of which had been added a larger subsidiary city, which probably served as an emporium. Both were surrounded by high earth and laterite ramparts and a broad moat, and in the centre of each enclosure was a large rectangular lake.

Primitive Indian Temple

Since all traces of the royal palace and of the dwellings of the various castes had disappeared, because they had been built of wood, the most important monument that remained was a purely Indian brick temple, standing in the centre of the main city. It was a simple brick tower resembling the temple at Bhitargaon in the Cawnpore province of India, and dating from the 5th or early 6th century A.D. Previously it had been thought that the early Indian colonists had built only temples of wood, of which no traces could remain, but the discovery of this purely Indian brick temple has disproved this theory. This brick tower is thus the oldest known Hindu temple in Indo-China, and its extraordinarily simple construction, lacking all the specialised features of later Indo-Chinese temples, indicates that we have here an example of the earliest colonial type of Indian architecture, a product of the Gupta period, and even more primitive than any we had examined.

Several fine sculptures of the same early period were discovered lying in the jungle, which by their graceful form and suppleness of line are also characteristic of the great Gupta school of India. In some cases the heads were missing, but the one illustrated here is remarkable in that its head, one of the noblest found at Sri Deva, is the only part that remains in a good state of preservation. Most of these statues represent Vishnu, and an interesting Sanscrit inscription of the first quarter of the 6th century was also found which confirms that the inhabitants of Sri Deva were Vishnu-worshippers. The nature of the characters used in the inscription also points to the colonists having come from Telingana, north Deccan.

The Khmer Occupation

The city of Sri Deva seems to have been situated on an important trade and military route of the old Fu-nan empire, leading from the Kingdom of Fu-nan proper to the vassal states of the Menam valley; and in the 5th century, when the empire was at its height, the emporium must have been the meeting place of merchants bringing grain from Cochin China to exchange with Indian goods. But about 550 A.D., as stated above, the old Fu-nan empire fell to pieces as a result of the rebellion of the vassal states, and both the trade route and the city of Sri Deva were abandoned. In the 11th century, however, the city was for a time re-occupied by the Khmers and a number of ruins of that period also were found in the city. These consisted of a number of towers of provincial Khmer style, and vast laterite terraced structures reminiscent of the Bakong at Angkor. The Khmers were Siva-worshippers and numerous *lingas* were found. They converted the Indian temples to their own religion, throwing out the images of Vishnu into the jungle, and often mutilating them as well. They also built massive laterite roads and excavated new lakes. But their occupation was short and, fortunately, their activities have done little to obscure the original Indian aspect of the city. For it is the existence of the Indian temple and sculptures, a direct link with the colonists of the Gupta period and at the base of the whole later evolution of Indo-Chinese and even of Indonesian art, that make Sri Deva of such prime importance in Greater-Indian archæology.

Stereochemistry.

By Peter Maitland, B.Sc., Ph.D.

Substances which have the same written chemical formula are not necessarily of the same structure. The individual atoms composing the substances may be built together in many different ways. In this article the arrangement of the atoms in space is considered, and especially where that arrangement is connected with an optical property.

THE branch of chemistry which is concerned with the *arrangement in space* of the atoms composing a compound is called Stereochemistry. Since the whole subject has been developed around the study of the compounds of carbon, the stereochemistry of this element will be considered first.

When a chemist writes CH_4 as the symbol for the gas methane it merely expresses the fact that every single unit or molecule of the gas is composed of one carbon atom and four hydrogen atoms, firmly bound together; but this symbol gives no indication as to the arrangement of the atoms in space.

It is convenient in chemistry to show the linking between any two atoms by means of a line or lines, commonly called bonds. These bonds have no existence in fact, but they are extremely useful in visualising the arrangement of the atoms. Modern physics substitutes each single bond by two electrons, but for our purpose it is sufficient for us to make use of the connecting lines. Actually the atoms are not separated from one another as the bonds would tend to suggest but may be regarded as spheres in intimate contact.

If the molecule of methane CH_4 is written out in the

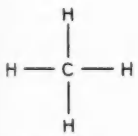


Fig. I.

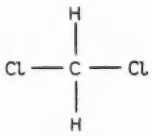


Fig. II.

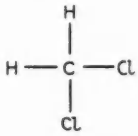


Fig. III.

graphic formula (I) as it is called, it appears that all the hydrogen atoms are symmetrically arranged around the central carbon atom: and that all the atoms lie *in one plane* (the plane of the paper). Now if this planar configuration were correct, then a compound of the formula CH_2Cl_2, in which two of the hydrogen atoms of the methane molecule have been substituted by chlorine (Cl) atoms, would exist in two modifications (II and III) where in the one case the two H atoms (and also the two Cl atoms) are lying opposite one another, and in the other case where each H atom is lying opposite to a chlorine atom. The compound CH_2Cl_2 and many others of this type were therefore investigated, and proved to be absolutely homogeneous. In addition to this, evidence began to accumulate from other sources that the planar arrangement of the groups around a carbon atom was not possible.

The first evidence came from the brilliant researches of Pasteur in 1848, which will not be described in detail

Fig. IV.

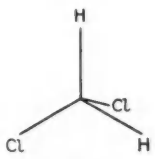


Fig. IIa.

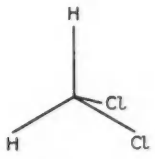


Fig. IIIa.

at present owing to the complexity of the stereochemistry of the compound with which he worked. Let it suffice for the moment to say that Pasteur investigated three forms of tartaric acid $C_4H_6O_6$, one of which, in a special optical instrument called the Polarimeter, gave a positive reading and was called the *dextro* form, another which gave a negative reading of the same magnitude and was called the *laevo* form, and a third which was optically inactive and which he called the *racemic* form. Pasteur put forward an explanation of this remarkable new phenomenon, based on the arrangement of atoms in *three*-dimensional space around the carbon atoms, but at this time the evidence upon which a conclusion could be founded was insufficient.

It was not until 26 years had elapsed that further progress was made. In 1874 van't Hoff and Le Bel both showed independently that there was a definite relationship between the structure, or spatial arrangement, of a carbon compound and its optical properties. They postulated that the four atoms (or groups of atoms) around the carbon atom must be arranged at equal distances and angles in *three-dimensional* space, that is, at the four corners of an imaginary regular tetrahedron. In the diagram (IV) the dark lines represent the bonds radiating from the central carbon atom and the dotted lines the regular tetrahedron.

If the two compounds of formula II and III are now examined in the light of the tetrahedral theory they will be seen to be identical (IIa and IIIa). Thus, by simple

rotation on the vertical axis, IIa may be obtained in a form completely superposable on IIIa.

Van't Hoff and Le Bel both recognised that, for a substance to be optically active in solution, there must be four *different* atoms or groups around the central carbon atom. The central atom in such a case was called by them an *asymmetric* carbon atom.

Let us first master the difference between *symmetry* and *asymmetry*. The idea of symmetry of any object implies that it is possible to divide it somewhere into

Fig. V.

similar parts, and also that its image (in a mirror) if it could be made concrete, would be completely superposable on the object itself. The idea of division therefore involves the presence of a *plane of symmetry*. Thus a cricket bat has one plane of symmetry and one only, a plane which cuts the batting surface at right angles, exactly in the middle of the bat and the middle of the handle; and the mirror image of the bat would be completely superposable on the object itself. The same applies to a teapot, which has a plane of symmetry which bisects the spout and handle. A perfect ball or sphere is also a symmetrical object, but unlike the teapot and cricket bat it has many planes of symmetry, all of which, however, must pass through the centre of the ball.

Asymmetry on the other hand means simply lack of symmetry, and an asymmetric object has therefore no plane of symmetry. Common examples are a glove, a hand, a foot, or a shoe. None of these has a plane of symmetry and all are non-superposable on their mirror images. For example, the mirror image of a right hand is a left hand and these two cannot be superposed.

Returning now to the theory of van't Hoff and Le Bel, which connects the optical properties of a carbon compound with the asymmetry of the compound, they predicted that all carbon compounds whose molecules have this asymmetry (and this could only be true when there were *four* different atoms or groups attached to the carbon atom) would show the optical properties already described. To make this asymmetry clear let us consider a simple carbon compound.

The carbon atom in figure V (a) and (b) is imagined to be at the point where all the bonds intersect and has attached to it four different groups D, E, F, G. If we imagine a mirror placed at M then the mirror image of (a) will be (b). It can be shown from models that (b) is non-superposable upon (a). Let us try to show this with our inadequate drawings of models projected on paper above. Bring the molecule (b) on top of (a) in such a way that the groups D and F are superimposed. Then it will be seen that the groups G and E from (b) land on E and G from (a). All other attempts to superimpose these two molecules (a) and (b) would meet with the same failure. The relationship of these two molecules is that of a right and left hand: both are hands, identical in every respect, but a right hand cannot be superimposed on a left hand. If a carbon compound therefore, as described above, has four different atoms or groups on it, it can exist in three forms.

(1) Where the compound is composed of nothing but (a) molecules and is therefore the *dextro* (say) form, or dextro rotatory form, because it gives a right-handed or dextro rotation when examined in the polarimeter.

(2) Where the compound is composed of nothing but (b) molecules and is therefore the *laevo* form.

(3) Where the compound is composed of equal amounts of (a) and (b) forms and is therefore optically inactive (the *racemic* form).

It must be stressed that the dextro and laevo forms of such a molecule have absolutely identical physical and chemical properties (with the exception of the optical properties) and that on account of this they can be separated only by very special methods.

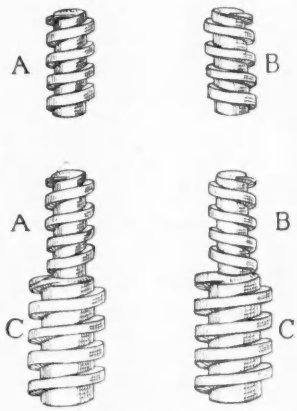


Fig. VI.

[*From Sherwood Taylor's "Organic Chemistry"* (Heinemann) *by permission of the publishers.*

When a substance containing an asymmetric carbon atom is "synthesised" or built up in the laboratory from simpler substances, the inactive form always results, because the d- and l- forms are produced in equal amounts. If the substance is found in Nature, however, the d- or l- form is sometimes produced alone. It is often very necessary in research, in order to establish a particular theory, to show that the synthetic substance does actually consist of d- and l-

molecules, and several methods have been elaborated for separating the two forms from one another.

Three of the methods of separating of the right- and left-handed molecules will now be described.

(1) To the solution of the racemic (optically inactive) modification of the substance are added some fungi or bacteria. These possess the remarkable property of discriminating between the d- and l- forms and show a definite preference for one or the other of the two forms. Thus Pasteur in 1858 showed that a derivative of the racemic form of tartaric acid, if left in contact with the mould *Penicillium glaucum*, became slowly laevo-rotatory owing to the selective destruction of the dextro form; and many more examples of this type have since been discovered.

(2) A solution of the inactive form is allowed to crystallise slowly in such a way that large crystals are formed. The crystals on examination are sometimes found to be capable of mechanical separation into two kinds, which are related to one another as a right hand is to a left, that is, as an object to its non-superposable mirror image. If each set is now dissolved in some solvent and a reading taken in the polarimeter, one will be found to give a positive reading and the other a negative reading of the same value, if solutions of equal concentration have been used. This method is of limited application because in most cases crystallisation of the inactive form gives pure homogeneous inactive crystals of the unchanged substance.

(3) The third method is the most widely used. It makes use of the fact that in Nature optically active forms of acids and bases (as well as of other types of compounds) are found. In order to make this explanation clear reference will be made to a simple asymmetric object, a screw. In the figure VI let us suppose that A and B, which are non-superposable mirror images, are the dextro and laevo (or d- and l-) forms of an Acid. The problem is to start with the inactive (racemic) form of the acid, which is a mixture of equal numbers of A and B molecules, but inseparable by ordary methods, and "resolve" it into the d- and l- forms. A solution of the racemic form (or racemate as it is sometimes called) is treated with the *active* form of a Base C, obtained from Nature.

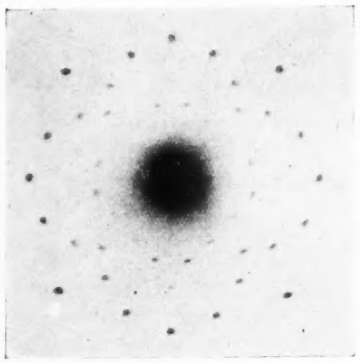


Fig. VII.

[*From Sir William Bragg's "Introduction to Crystal Analysis" (Bell) by permission of the author and publishers.*

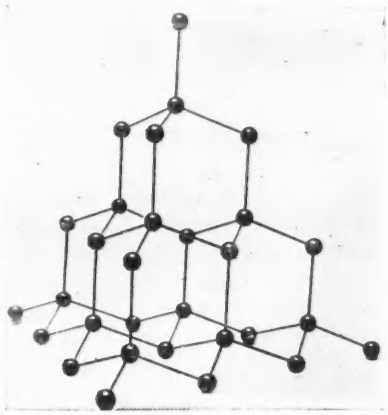


Fig. VIII.

[*From Sir William Bragg's "Covering the Nature of Things" (Bell) by permission of the author and publishers.*

A base has the property of combining with or neutralising an acid. Let us assume that the dextro form of the base is used, although the argument would apply equally well for the laevo. The d-Base or right-handed screw C combines in the solution with both the A and B forms of the Acid; but whereas before combination A and B were non-superposable mirror images and therefore inseparable by all the usual chemical or physical means the new molecules AC and BC are still very similar but no longer mirror images. Small differences in physical properties, such as solubility in a solvent, now become evident and by allowing a hot saturated solution of the mixture to cool and deposit crystals it is found that one form only, say AC, predominates. These crystals are filtered off and the mother liquor from which they came is concentrated until on cooling crystallisation starts again. This second crop contains mostly the BC form. Actually this process of separation is much more elaborate and tedious, involving in many cases over twenty such fractional crystallisations: but the final result is the same as that described above—the separation of the substances AC and BC. The crystals AC are now taken and treated in such a way as to remove the basic part C and we are left with the pure dextro rotatory form A of the Acid. Similar treatment of BC gives the laevo form B.

So far we have been dealing with the simple case of a compound containing only one asymmetric carbon atom, and we have seen that this leads to the production of three forms of the compound, d-, l- and racemic. When the compound contains two or more asymmetric carbon atoms the number of forms possible increases tremendously. When there are n asymmetric carbon atoms the number of active forms is given by 2^n and

the number of inactive or racemic forms as $\frac{1}{2}$ of 2^n. Thus a compound containing four asymmetric carbon atoms will have 2^4 or sixteen active forms and eight inactive, twenty-four forms in all. A compound of general formula $C_6H_{12}O_6$, belonging to a class of organic compounds known as Sugars, and occurring widely in Nature, has four such asymmetric carbon atoms, and the achievement of separating the twenty-four forms is one of the wonders of organic chemistry, and was carried out by the famous German chemist, Emil Fischer. This successful separation was also a wonderful experimental proof of the correctness of the van't Hoff theory of the tetrahedral arrangement of the carbon valencies or bonds. When van't Hoff first brought forward his theory in 1874, like many another revolutionary theory it was severely criticised by many of the older outstanding chemists of the day. One of these, Kolbe, made the following caustic comment, "A certain Dr. J. H. van't Hoff, an official of the veterinary school at Utrecht, has, it seems, no taste for exact chemical investigation. He has thought it more convenient to bestride Pegasus (evidently hired at the veterinary stables), and to proclaim in his *La Chimie dans l'Espace* how, during his bold flight to the top of the chemical Parnassus, the atoms appeared to him to have grouped themselves throughout universal space" ; but van't Hoff was right, and all the research done since 1874 has only served to produce further conclusive proof of the correctness of this brilliant theory.

Modern methods of X-ray analysis offer an even more convincing proof of the tetrahedral theory. A beam of X-rays is directed on to a crystal of the substance to be examined and a photographic plate is placed behind the crystal. Many of the X-rays go straight through the

Fig. IX.

crystals and this explains the appearance of a black circle in the centre of the plate (Fig. VII) ; but some knock up against the atoms and are deflected and the result of such an experiment is seen in the diagram. From the pattern obtained the arrangement of the atoms causing the numerous deflections is deduced by mathematical reasoning.

X-ray crystal analysis, first indicated by experiments which were suggested in 1912 by Professor Max von Laue of the University of Zurich, was developed in this country by Sir William Bragg. Fig. VIII represents the arrangement he deduced for the carbon atoms in a diamond, which is simply carbon in a crystalline state. It is difficult to believe that the black carbon which we meet in ordinary soot is exactly the same substance as a beautiful object like the diamond, but such is the case, for soot and diamonds are composed of nothing but carbon atoms, arranged heterogeneously in the former case and homogeneously in the latter. In the figure the tetrahedral arrangement of the atoms, deduced mathematically from the X-ray photographs, is apparent. Each carbon atom lies at the centre of gravity of a tetrahedron formed by its four nearest neighbours.

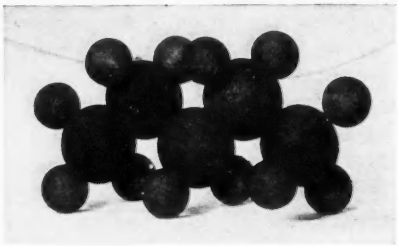


Fig. X.

[From Sir William Bragg's "Concerning the Nature of Things" (Bell). By permission of the author and publishers.]

A clearer picture of the actual appearance of a molecule composed of several atoms is obtained by considering the molecule of the substance normal-pentane C_5H_{12}. The ordinary graphic formula would appear like Fig. IX ; but Fig. X, in which the atoms are drawn as spheres, gives a much clearer idea of the appearance of the molecule. The larger spheres are the carbon atoms and the smaller the hydrogen atoms. It should be realised that all the atoms are free to rotate on the axis of their linking, and that in the figure only one of the many possible positions of the carbon atoms is shown. Modern physics has produced evidence to show that the atoms are actually spinning.

The foregoing article is intended to be an introduction to the fascinating subject of Stereochemisty and, of necessity, many branches of it have not been touched upon. If it proves, however, to be of sufficient interest to readers the subject will be developed later.

Recording Bird-Song.

The first records ever made in this country of the songs of its wild birds were heard at a private gathering at the Royal Society of Arts, on October 6, when Mr. E. M. Nicholson and Herr Ludwig Koch introduced their book "Songs of Wild Birds."

This book, published by H. F. & G. Witherby, is accompanied by two gramophone records, made by a new German process, direct from bird songs in the field. More than a dozen birds are featured, and the songs are reproduced in beautifully clear tones. The book itself contains coloured illustrations.

Dr. Julian Huxley was present at the audition, and spoke in warm support of this method of familiarising bird-song.

The Story of Stone Money

By Willard Price

The stone currency of Yap, in the Caroline Islands, is unique in appearance, but has one thing in common with all other money: undue love of it has never failed to cause trouble. How this money came to Yap, and how it circulates even to-day provides material for a fascinating and out-of-the-way story.

THE strangest money in the world is perhaps the money of Yap. Certainly, it can go on record as the largest. When I visited this curious isle in the Carolines and saw, on my first day ashore, a man rolling a coin as tall as himself, I felt that the heat must have got the better of me. But I soon found that such coins are common in Yap. In fact some are twice this size. Place one such on edge, and a tall man must stand on a tall man's head to reach the top. In the centre of each coin is a round hole. In an important coin, this is as large as a manhole. When the coin is to be paid, a tree is thrust through the hole and a crew of perhaps one hundred men, half on each end, partly lift and partly drag the coin over the ancient stone-paved jungle-trails to the creditor.

A Yap native carrying a stone coin, and wearing the characteristic mangrove-wood comb.

In the port-town, Japanese money is used—for Yap is under the control of Japan. But in the jungles Japanese money is rarely seen. The ancient stone money is still used.

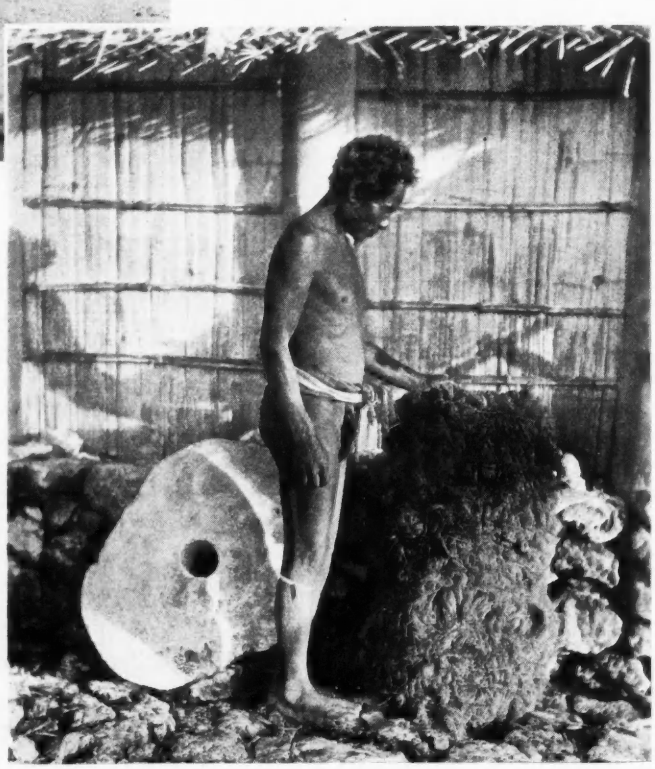
A native king in a jungle village accommodated Mrs. Price and myself in his crude, dark, thatch palace. The kings are still allowed to govern their districts without much interference from the Japanese. Our hostess, the queen, one morning wanted to go shopping. She did not sally forth with a pocketbook. She went down the shore path under the palms followed by two slaves sweating under the weight of two three-foot stone discs supported on their shoulders by bamboo poles thrust through the holes.

The village trader accepts such currency cheerfully. Of course he cannot exchange it for foreign goods; but he can pay it to some other native for coconuts.

How did Yap get such an unwieldy coinage? The tradition is that a thousand years ago one of the more disreputable gods thought to cause dissension among men. They were at peace because they had nothing to war over. He would give them something to fight about: money. He whispered to a king of Tomil (one of the sections of Yap) a plan to make him great and powerful. Obedient to the heavenly vision, the king sailed south over unknown waters to islands of the Palau group. There he found shining rock (calcite) which the malicious deity instructed him to have his men hew out with their shell-axes into flat pieces rounded like the orb of the full moon. These were loaded into the canoe and brought to Yap, not without many perils. The god cast a spell over the people that caused every man of them to desire nothing so much as one of these heaven-sent stones. To obtain them, they paid to the king of Tomil great riches in the form of coconuts, canoes, and houses. So the wheels became a medium of exchange for goods.

And those who tell the legend go on to say that there has been no peace in Yap since then. The golden (or stone) apple of discord disrupted the peace of the island paradise. Formerly there had been no covetousness; for there was nothing to covet. No man desired his neighbour's coconuts for he had his own. There was food enough for everyone and no one wanted clothing. Greed was born when money came in. There was quarrelling among relatives as to who should inherit which rock; feuds between neighbours; and wars between villages. The elders of Yap, ignorant of the fact that the Bible describes the love of money as the root of all evil, have learned that truth from bitter experience.

There was only enough of the first money to be tantalising. Expeditions set out to get more. They went not only to Palau but to Guam where an even finer stone could be obtained. But it is four hundred miles to Guam and the seas are stormy. Many canoes were lost, particularly on the return voyage when loaded to the danger point with great stone wheels. It was not



Above: A piece of Yap money twelve feet in diameter and weighing over a ton. Right: A Yap stone coin and a bale of coconut fibre, containing lava-lavas, also used as money.

uncommon for twenty canoes to set out for Guam and only one to return. Of course the difficulty and danger in securing the stone kept up its value. There could be no counterfeiting, for there was no similar stone to be found in Yap. It is a calcite or crystallised carbonate of lime which forms in veins, filling the cracks in limestone or other rock. There is nothing inherently precious about it. It has value to the Yap native only because it is hard to get and because it is the accepted medium of exchange.

These goings-on amused not only the god but an Irish buccaneer named O'Keefe. This worthy cast anchor in Yap harbour during the Spanish rule (a rule that was largely characterised by the lack of any) and proceeded to look the natives over with a view to making what he could out of them. He soon found that they would give copra, fish, anything they possessed, for stone money. He heard that large pieces were especially in demand; and his schooner could transport pieces many times as large as could be carried in canoes.

I found an old native sailor with the shamrock tattooed on his brown skin who had sailed with Captain O'Keefe for years. He told me the story.

"He sailed to Palau and went to the king. He asked for many men to help dig stone money. The king said, 'What will you give?' The Captain gave rope. He gave paint to paint the bodies of the dead. Dye to colour lava-lavas. And some guns. He promised to give more when the work was done.

"The men of Palau dug . . . many years. Small stones took little time. But it took two years to dig out a great wheel. We kept taking the wheels to Yap and selling them to the natives for copra. But

the chiefs of Palau soon became angry because he paid no more and was cruel to the men. They looked for a chance to punish him."

The opportunity came when O'Keefe was wrecked in the Palau group. The natives seized all his goods, lashed him to a tree, and flogged him with a cat-o'-nine-tails salvaged from his own ship.

After his release he lost no time in lodging complaint at Hong Kong. A warship visited Palau and demanded an indemnity in the form of large quantities of copra and bêche-de-mer from the offending village of Alklung.

Time passed and the indemnity was not paid. Then came two warships, H.M.S. *Lily* under Captain Evans and H.M.S. *Comus* under Captain East. Their men landed and burned the village to the ground, while the people fled to the interior.

Kanaka woman using shell money to buy bottles of petroleum from a Chamorro trader.

Captain O'Keefe sowed trouble by supplying the natives with guns, but he was not the only trader to do that. For one gun he must have fifty five-gallon cans of turtle shell, or fifty rice bags of bêche-de-mer. Several old chiefs of Yap and Palau recalled only too well how the doughty Captain had taken a gang of natives to work on his island, Mapia, near New Guinea . . . . and left them there. He said it was too much bother to bring them back. The survivors of the marooned finally attracted the attention of a passing ship and were rescued. "When he saw anything he liked," said a reminiscing chief, "he would take. A pig—'Put it on board. I'll eat it,' No pay. Bad man. But when the Germans came they stopped his wild tricks."

Life lost its savour after that for the burly and jovial buccaneer. The Germans (who ruled the islands after the Spaniards left and before the Japanese came) hedged him in with prohibitions. One day he stocked his schooner for a long voyage, and sailed away. He never came back. Some say that he went to an island known only to him, for he was an excellent navigator and knew the South Seas as few men did. Others suppose that he was lost at sea. However that may be, he left behind him monuments that will stand to his memory for thousands of years. The largest coin of his minting that I saw measured twelve feet across and was estimated to weigh about two tons. But the greatest of all is said to lie at the bottom of Yap harbour. While being transferred from the schooner's deck to a raft, it slid into the water. The old men who saw it swear that it was twenty feet wide.

The great museums, naturally, want some of these monoliths, unique in the history of the world's coinage. They have taken a few of the smaller ones; but have not yet undertaken to bargain with the natives for a giant stone, and ship it to the other side of the world. The natives might well do without the stones, for they have brought them nothing but trouble. Lacking currency, they would step back to the stone-age system of barter. Nor would it be a long step, for in fact barter is used to-day in most Yap transactions. The clumsiness of the stone currency makes it easier to trade goods for goods, using no money.

There are standard terms understood by everybody. Two coconuts sell for one match. Ten nuts will buy one roll of bread. Ten nuts are the equivalent of one pack of Golden Bat cigarettes. The man who has brought his nuts from a great distance may demand and get one or two cigarettes extra. Ten leaves of tobacco buy twenty-five nuts. One cider-bottle of petroleum goes for twenty nuts and a beer-bottle of petroleum is paid for forty nuts.

The natives sell chickens, eggs, pigs, in the same way . . . for petroleum, phonographs, harmonicas, not for money. They do not understand money in the form of small silver and copper pieces, so insignificant compared

with their majestic coins of stone. Who knows how long this foreign money will be good? First Spanish money came. Then German money, and Spanish was no good. Then Japanese money, and German was no good. But stone money is always good. It goes on for ever.

Stone is not the only form of Yap money. Shell of the pearl oyster are strung together and used as currency. Bags of copra are used. Also the remarkably fine lava-lavas produced by the artists of the neighbouring island of Mokomok. A sack of these lava-lavas was kept as one of the chief treasures of the "All Men House" (council house) in our village. There was no thought of opening it and using the garments. It was kept intact to be paid some time to another village for a canoe. But barter and these lesser currencies are used for only small transactions. For a great one, stone money comes into play.

The foreigner who regards these stones as of little value will be sharply disillusioned when he tries to buy one. He must pay goods to the value of about fifteen pounds for a Guam wheel a foot in diameter! The Palau wheels cost less. A poor specimen, waist-high, is valued at four thousand coconuts, worth in the islands about five pounds. A stone man-high is worth many villages and plantations, and the stones two-men-high are considered to be beyond price.

Money on Show.

The great stones, of course, will not be owned by individuals but by communities. They are displayed outside of the All Men House which thereby acquires the native name, "Febai" (Money House). Private homes are flanked with smaller pieces, from two to five feet high. The Yap resident would think it as curious to take his money inside the house as we would to leave ours in the yard. How could anyone see your money if you kept it in the house? Moreover, there would scarcely be room left for the family. However, the small pieces, six inches or so in diameter, are kept indoors. Not only because they would be too easily carried away if left outside; but because the householder would be ashamed to show them. It would be like displaying pennies. He would be thought a poor man.

Therefore large stones are in demand. Rather than accept small wheels, the creditors prefers to let the bill mount until he can be paid with a handsome wheel big enough to attract real attention as it leans against his house or against the stone platform upon which his house is built.

Such coins are rarely stolen. It is hard to slip away with a half ton of rock. Still, it could be done while the people of the house are absent. But where could one take the booty? It would be futile to remove it to some island outside of the Yap group because, there, such currency is not used. If it is kept in the Yap islands it will be traced. There are no inscriptions on these coins by which to indentify them; but the details and measurements of every wheel are memorised by the owner. He would recognise his wheel anywhere.

The larger wheels even have individual names and are known by name and appearance to everyone in the islands. They are even better known than people; for people come and go, are born and die, but these familiar faces remain from generation to generation. Every wheel has its story, usually a story of blood, of fighting between villages for possession of the piece of rock, or of feuds between families, or of efforts to steal and hide the money, or of the killing of its owner by poison or a spear-thrust. There are records of half the men, women, and children of the island being slaughtered in a money foray.

To-day the mint is idle . . . no more stone money is being "coined." This may be partly due to the growing competition of Japanese money. There is a greater reason. The population has shrunk to half its former size while the supply of money has remained the same. In other words, Yap's currency is inflated. Also, the value of labour has risen, that it would cost more to go to Palau and dig out new wheels than the wheels would be worth.

Although the use of the wheels as currency is slightly decreasing, the hoarding spirit will long keep up the value of the old stones. As each family dies out its stones are quarrelsomely claimed by others, still giving delight to the malicious god aloft. As house after house is abandoned, the wheels pile around the homes of the survivors. As a result of wars, dissension, and disease, the race may die out. But the great stone wheels will remain, odd monuments to the evil of the love of money.

A New Filing System.

An indexing system which should prove of considerable benefit to all engaged in the pursuit of knowledge is now marketed by Mastrom, Ltd., of Birmingham. The purpose of the system is to enable students, teachers, scientists, and writers to organise the information they may require, and especially to keep track of those miscellaneous and valuable notes made *en passant* which are so easily lost. A loose-leaf binder containing an alphabetical arrangement of subject headings leads to a card index, systematised according to a key plan, which yields the precise source from which the required information may be obtained. The system, which has been perfected during ten years of practical experience, should be a great time-saver in drawing together scattered information existing in books, newspaper cuttings, pamphlets, and the like, and the price is only five guineas complete.

Measuring Dust.

By S. C. Blacktin, Ph.D., M.Sc.

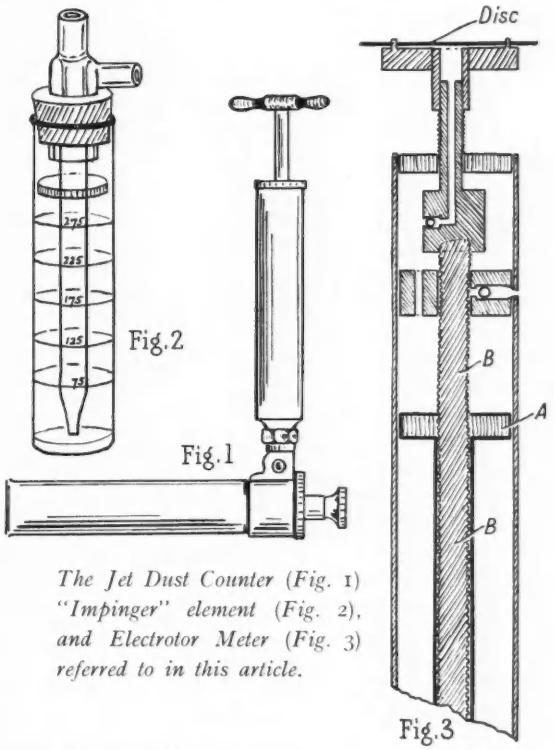
In the December, 1935, *number of* DISCOVERY *Dr. Blacktin presented a general outline of the meaning of Dust for Mankind; in this present article he describes in outline the instrumental means which have made it possible to assess such meaning, and are still available for adding further significance and detail.*

DUST, to the average intelligent person, is still so nebulous a floating something that he may be surprised—nay even shocked—to know that various instruments have been devised to measure the amount of dust he will breathe in with the air in his varied perambulations, whether these be to the factory, the office, the seaside resort, the pleasure cruise, the mountain region, the amusement house, or—to bed. It seems fitting that in this article the technique and operation of the various instruments should be discussed without any attempt to compare—or rather contrast—their relative efficiencies for the work of dust computation, in other than a very general sense.

In general experience fine particles are either "floating," or "settled." What is the difference? If "floating" the particles are not resting against one another and/or on a surface able to hold them, but are separated from each other or any such surface whether liquid or solid. If "settled" the particles are generally supported on, suspended from, or adherent to, some surface liquid or solid capable of holding them, with or without their touching each other.

In the colloidal region of matter, *i.e.*, in that region where the size of the units of matter is between one millimicron (one ten-millionth of a centimetre) and 100 millimicron diameter, particles which are "floating" are technically named Sols. They are separated and dispersed in gas, liquid or solid, which is called the dispersion medium. Afternoon tea is a colloidal Sol, the particles being dispersed through liquid—water—giving the characteristic amber colour. Particles in the colloidal region which are "settled" are called Gels. The jelly quivering on the table under the excited movement at children's parties is a Gel—in fact, Science may be indebted to it for this technical term. Its characteristic instability is due to the fact that it is formed of liquid particles—for particles can be liquid or solid—held closely within a framework of more solid gelatin, with a structure something like the cells in plant structure. All of which may seem very remote from instruments for dust counting, but is really not.

For all instruments which are used for measuring dust do so by either measuring it in its "floating" or sol condition, or in its "settled" or gel condition; and by far the majority measure dust in its gel condition. In fact only *one* instrument at present measures it in its sol condition in air or gas. Then why make a separate class of just one instrument? Because that instrument is a most important one not only for measuring dusts,



The Jet Dust Counter (*Fig.* 1) *"Impinger" element* (*Fig.* 2), *and Electrotor Meter* (*Fig.* 3) *referred to in this article.*

but also for studying all sorts of other matter, and because it has bridged the colloidal field and made it possible for study, between where the power of the microscope ends, and where the region of the molecule begins. This instrument is the ultramicroscope, which by specially illuminating fine particles so that they themselves shine with reflected light, makes them perceptible through an ordinary microscope when they would not otherwise be so. Whereas the instruments in the second class have been specially invented for dust study.

The ultramicroscope directs an intense beam of light on the particles sucked into a cell whilst they are examined through the accessory microscope of the

instrument. But it is a very special cell, and an electric arc, optical system, and cooling system are also needed. The suction system is also often bulky and complex, so that the whole ultramicroscope forms an ungainly and immobile collection largely precluded for more general dust counting since the dust must be captured and brought to the instrument. And dust does not remain inactive or unaltered in captivity.

Many Disadvantages

The intractability of the instrument therefore largely defeats the advantage of its simplicity of principle. Thus the special means for "settling" dust with the other instruments is made well worth while. Again, whilst the ultramicroscope probably gives counts nearest the actual number of particles, the intense illumination surrounds each particle with a halo of bright light so that it does not present its characteristic form and shape but appears as a little sun or star. All study of shape or surface of particles is thus denied. The ultramicroscope is therefore, the most inefficient instrument for giving information about individual particles. Its efficiency for dust particle determination must, at present, therefore be regarded as an important aspect of its general scientific value, only available in special cases where expense, time, and convenience are of small import.

The various instruments of Class 2 are now given consideration, firstly those which use Adiabatic Expansion.

This principle was utilised for the first dust-counting instrument by John Aitken in 1880. Aitken had found that even when air was supersaturated with moisture, water drops would not form in it without the presence of particles to act as nuclei of condensation. This suggested to him a means of counting the particles in the atmosphere. He invented an instrument having a chamber in which the air was overcharged with moisture, and adiabatically expanded, when drops were formed on the particles. The drops were received on a plate as they fell, and eventually counted, the count being taken as the number of solid particles. Aitken found that results were valid only if there were less than 500 particles present per cubic centimetre, and it was necessary to dilute dusty air with dust-free air very often, so as to reduce the particle number to less than 500 per c.c. If the dusty air were diluted in the ratio 20 : 1, and the count was then 400 particles per c.c., the number in the undiluted sample would obviously be 8,400 particles per c.c. The Aitken dust-counter has been considered by some to give counts too high for the actual dust particles, but whether this is so depends upon the definition of "dust particle."

J. S. Owens has invented a mechanical modification of the Aitken dust-counter which he has termed the Jet dust-counter. It is almost certain that whereas the Aitken counter gave too high counts, the Jet dust counter gives too low ones. It consists essentially of two metal cylinders held at right angles, and communicating with an intermediate metal chamber containing a bed on which a microscope cover-glass can be held down by a spring (Fig. 1). When the cover glass is in position, a slit 1 cm. long and 0.01 cm. wide, which forms the exit from one cylinder, is close to the exposed face of the cover-glass. The other metal cylinder is a pump tightly secured into the intermediate chamber. When the pump handle is drawn out, the air or gas sample in the other, hollow, cylinder which holds a moist blotting-paper lining to saturate its contents, rushes rapidly through the slit together with its dust-particle content. The particles are carried on to the slide as condensation centres for the moisture condensed on them by the adiabatic expansion occurring on the gases leaving the narrow slit for the comparatively voluminous chamber. On the cover-glass the particles form a narrow ribbon which can be microscopically counted, if not too dense. The cover slit can be revolved and further ribbon records obtained on it. The total number of particles deposited, divided by the number of c.cs. drawn through, gives the particle number per c.c.

Impingement Instruments

There are three well-known instruments which make use of the Impingement principle, *viz.*, the Greenburg-Smith Impinger, the Kotze Konimeter, and the Zeiss Konimeter, but while the two last are almost identical the first is very different. It was invented in the United States; the Kotze Konimeter came from South Africa, where it has been found of much use in the gold-mining industries in connection with silicosis. While all three instruments depend on the directing of the air or gas stream containing the dust in a jet against a barrier or plate, in the case of the Impinger this occurs under water (or some other liquid), throughout which the trapped particles are dispersed, but with the Konimeters it occurs in the air, and the particles are held on the barrier or plate for microscopic examination. The Greenburg-Smith Impinger, therefore, relies on *wet* impingement; The Konimeters on *dry* impingement.

In effect what the Impinger does is to change the air or gas dispersion-medium of particles for a liquid dispersion-medium, but it can hardly avoid changing or losing some particles in doing so, when the rate of sampling, *viz.*, 1 cubic foot per minute, forces the air-dust stream to pass through the nozzle of 2.3 mm. diameter, at about 270 miles per hour. The impinging portion of the Impinger is shown in Fig. 2. It is essen-

tially a length of glass tubing held centrally and vertically within a glass bottle by the bottle-stopper. The central tube's lower extremity is drawn out to an orifice 2.3 mm. diameter, which is fixed at a small distance from the bottle base by alignment with a graduation mark on the bottle exterior, and from 10 to 30 cubic feet of the air or gas is drawn through the impinger tube, where its dust-particle content is halted on striking the barrier, wetted, and trapped in the volume of liquid known from the graduation marks on the bottle. This instrument has a great vogue in America, but although its principle is simple, its operation is cumbrous, since it requires bulky and expensive accessories.

Thus, to maintain a suction at the speed mentioned against the pressure head of the liquid in the bottle, plus atmospheric pressure of about 14 lb. per square inch, for from 10 to 30 minutes, a powerful vacuum pump driven by a $\frac{1}{4}$ h.p. motor, or a compressed air ejector working between 30 and 70 lb. per square inch, must be employed; a tripod for the instrument must be carried; and a separate bottle and liquid for each sample to be taken. Moreover, trapping liquids have obviously to be chosen in which the particles being estimated are not soluble, and special precautions have to be taken in sampling the resultant liquid and in counting the particles in the liquid sample. The bulky accessories obviously hamper and restrict the application of the simple principle shown in Fig. 2.

Perhaps the chief distinction between the two Konimeters is that the Zeiss instrument has a small microscope attached to it for examining the record. Although they otherwise differ in detail, in each case a small volume of several c.c. of air or gas is impinged by mechanical suction against a glass plate smeared with grease. The instruments are self-contained, convenient, portable and rapid in operation, but their value is, unfortunately, limited to dust dispersions containing relatively few numbers of particles, say up to 2,000 particles per cubic centimetre, only. The spot record is examined and counted under the microscope.

Operation Time Factor

For practical purposes the operation time of instruments is often an important matter. The time factors of the instruments already considered are :—Jet Dust Counter, several seconds; Konimeters, several seconds; Impinger, 10 to 30 minutes. All Natural Settlement instruments have a quite different—and much longer—time factor, owing to the slowness with which minute particles settle. This slowness—a matter of hours—must also be accompanied by great care, so that although settlement instruments are very efficient, their use is precluded for the more general determinations. There are two settlement instruments, both dependent on the trapping of the air or gas in a hollow metal cylinder. For dust clouds normally sampled, the cylinder is about 5 cm. high. When the sample is enclosed by placing the lid on the cylinder, all the particles will settle on the cover-glass carried on the sliding base—if sufficient time is given. This period is dependent on the application of Stokes' law, and hangs on particle size, density, etc., but for a 5 cm. cylinder may be taken as about 3 hours. After this period the cover-glass is removed and its particle deposit counted. The instrument for larger particles has a longer settling column. These instruments are more suitable for measuring heavier dust dispersions than lighter ones.

The Electrotor

The Electrotor dust and smoke meter employs an electric field produced by static electrification and, therefore, needs no heavy battery encumbrance. It possesses maximum convenience and portability, and has a time factor of but several seconds. It covers an extremely heavy range of dispersions, in fact, extending further than any of the other instruments considered in this article—whether of short or long time factor—combined with a high counting efficiency. Its mechanical operation is ingenious, though simple and sturdy, and needs only ordinary care. The principle employed is that when the pump handle is moved either one way or the other, the plunger A, Fig. 3, similarly traversing the pump cylinder, rotates the archimedean screw B either one way or the other, at the same time that the plunger movement is either drawing air or gas into, or ejecting it from, the pump.

To the archimedean screw a disc of material, such as celluloid, which becomes electrified on rubbing, is attached horizontally. This disc (which receives the dust record) thus rotates as the screw rotates, and is electrified by contact against the adjoining surfaces. An inward movement of the plunger rod rotates and electrifies the record disc and empties the cylinder. An outward movement rotates it in the opposite direction, further electrifies the disc, and at the same time the air or gas stream with its dust or smoke particles is drawn against the electrified disc surface through the ingress hole(s).

By a special arrangement, a choice of ingresses may be made so that the record area can be varied to suit the heaviness of the dispersion. As each ingress provides a circular record of different diameter for the same number of particles, the spatial arrangement of particles varies on each circle. Thus, the most countable deposit may be chosen. Furthermore, due to the rotation of the disc, this instrument has an important feature possessed by no other. In all others considered, a clean surface is

presented only to the particles first arriving, *i.e.*, most particles have an increasingly small chance of not falling on and obscuring previous particles, thus spoiling the count. With the Electrotor meter a clean surface can be presented to all arriving particles. Thus, the Electrotor meter is able to present particle-appearance to a maximum degree, though the ultramicroscope, as explained, presents it to a minimum extent.

As the Electrotor meter has a hand-operated pump movement, motive-power accessories—like electric batteries—are not required. The human factor which may be sometimes a disadvantage in hand-operated instruments has been found reliable in dust-counting instruments. It is often desirable to find the proportions of particles of different size in a dispersion. Owing to the rotary motion of the disc whilst the particle deposit is being laid, a centrifugal action is set up which tends to arrange the particles in a definite size order. This facilitates proportion-counting.

Instruments employing electric current are dependent upon electric batteries as accessories, which necessarily limits their convenience and portability. In the case of the thermal precipitator, the electric current is used to heat a metal wire. The heated wire then repels the dust particles borne in the air or gas stream, which is drawn slowly past the wire, the particles being received as two ribbon records on relatively cool microscope slides. The time period is about 10 minutes, and whilst the instrument may be regarded as giving high counts, an aspirator or other suction apparatus must accompany the battery as a further accessory, together with a tripod to support the instrument. The complete instrument is, therefore, somewhat cumbersome, and the hot wire must be kept carefully adjusted to give good records.

Thermal Precipitation.

In the electrostatic precipitator, the electric current is used to create a field between electrodes. The dust particles are passed through this field and are deposited on the electrode(s). This is a modification of the well-known industrial electrostatic precipitator of Lodge, Moller and Cottrell. P. Drinker probably first used it in the U.S.A. for dust estimation, as distinct from large-scale dust recovery, the particles being received and counted on celluloid sheets in contact with a special glass tube wall which operated as one of the electrodes.

Almost all the instruments outlined have been made the subject of patent rights by the respective inventors. In the following table, approximate figures comparing the times of operation of some of them, together with the range of dispersions (*i.e.*, particles in unit volume of air or gas) roughly covered, are given :—

	Konimeters.	Jet Dust Counter.	Thermal Precipitator.	Settlement Counter.	Electrotor Meter.
Time period	2 sec.	2 sec.	10 min.	3 hours	2 sec.
Range for countable records (particles per cc.)	1,200 to 2,000	10,000	20,000	*over 2,000,000	*over 3,000,000

*Using a one-fifth inch microscope objective.

In conclusion it must be noted that there are other instruments which deal, not with the number of dust particles dispersed in air or gas—as all those considered do—but with the weight of solid matter which the particles represent. Space consideration prevents their lengthier mention in this article, although, of course, they are quite important. But, for example, in such measurements as those made in the attack on the dread Silicosis, it is not the weight of the dust breathed, but the numbers of the finest particles breathed, which matters. At the same time, a greater weight of such finest particles will be more dangerous than a smaller weight of them.

What the Little Owl Eats.

" It is a trait in the character of all English people to offer hospitality to all and sundry, from *homo sapiens* downwards," writes Mr. H. L. Elwell in *The Fruit Grower*. " But when it is proved to be against our own interest to continue doing so," he continues, " steps must be taken to safeguard ourselves and those dependent on us.

" For the past twelve months I have taken each month the contents of the stomach of the little owl and their pellets. These have shown that beetles predominate, especially during August and September, earwigs, mice, short-tailed and wood mice, earth worms, quantities of grass (probably taken for cleaning out the walls of the stomach), flesh in various stages of digestion, which it was impossible to identify, and quantities of grit, presumably taken to grind up the larger wing cases of the beetles.

" From this we can only come to one conclusion, and that is that the little owl is apparently doing no harm. But this is the wrong conclusion, as when we come to examine the contents of the larders of these birds and the food which they have brought to their sitting mates on the nests, the wholesale destruction of our wild birds is appalling, and this when the breeding season is in full swing, the source of supply for the continuance of our song birds being therefore seriously curtailed, to say the least of it.

" The result of this systematic slaughter is already becoming noticeable, as in the case of the red-backed shrike, or butcher bird. In the county of Gloucester, 15 or so years ago, this bird was common. To-day it is a very distinct rarity, as is also found to be the case in other counties where the little owl is not controlled by gamekeepers."

The Year's Photography, the annual publication of the Royal Photographic Society (*2s. 6d.*), contains 68 photogravure plates demonstrating that the high standard of technique in photographic practice, to which we have become accustomed, is being well maintained. The natural history photographs are as fascinating as ever, and the portrayal of certain rare plants and shy birds has been carried out with great skill and distinction.

The March of Knowledge.

Jack's Beanstalk

A Hungarian doctor, following the line that certain dyes hasten the healing of wounds, has discovered that plants may similarly be encouraged to develop five times their normal size and mature much earlier. A fertilising dye has been prepared, in powder form, to be mixed with water and poured over the newly-planted seed, the strength of the solution varying with the kind of plant : too much would have a reverse effect. Actually, the dye makes plants abnormally sensitive to sunshine, which accounts for the name, " photosensin."

New Island

A new island has been discovered in the south-west Pacific by four Sydney men, Norman K. Wallis, Henry Newton-Scott, John W. Forsyth, and Gilbert Whitley (ichthyologist to the Australian Museum), states *The Pacific Islands Monthly*. Cruising in the schooner *Wanderer*, the party came upon the island lying in the four-mile-wide Elizabeth Reef, north of Lord Howe Island. It was taken possession of in the name of King Edward VIII, and called Forsyth Land, after Forsyth who forecast its use as a seaplane base on the Sydney-Fiji-America route.

Motor-car of 1888

An 1888 Benz three-wheel motor car, which has been on exhibition in the Science Museum galleries since 1914, has been overhauled and put in working order, and is being demonstrated in the Museum grounds, where it runs in the road on the south side, outside the staff entrance to Gallery 7, on Wednesdays at 3 p.m. The car is driven by a single-cylinder four-stroke engine, having a vertical crankshaft, and the horse power is stated to be " about two."

Canada's Reindeer

The annual round-up of the reindeer herd recently acquired by the Canadian Government has been completed. The herd is growing rapidly and the number has now reached 3,750. The fawning, which took place during April, May and June, on a well protected grazing area east of the Mackenzie river, resulted in the addition of 936 fawns to the herd. This figure was made up of 498 females and 438 males. While there were the usual unavoidable losses due to sudden storms and intense cold, officers in charge of the herd state that the fawning was very successful and that the general condition of the deer is excellent. The annual round-up was completed on August 8, when the animals were put through the corrals and counted. The count showed that in addition to the above number of fawns, the herd included 1,762 adult females, 608 yearling and adult bulls, and 444 steers. During the winter of 1935-36 some 300 surplus animals were slaughtered to provide food and clothing for the assistance of natives in the Aklavik region and for other departmental purposes. This year's total indicates an increase of nearly 1,000 in the size of the herd, which is considered highly gratifying.

2nd Largest Brain

The Smithsonian Institution announces that Dr. Ales Hrdlika, its Curator of Physical Anthropology, unearthed a skull in the Aleutian Islands this summer having a brain capacity of 2,005 cubic centimetres. As far as is known this is the second largest skull on record. The largest is that of Turgenev, the Russian novelist, which had a brain capacity of 2,030 c.cm. After the Aleutian skull rank those of Daniel Webster, 2,000 c.cm., Bismarck, 1,965 c.cm., Lafontaine, 1,950 c.cm., Beethoven, 1,750 c.cm., and Kant, 1,740 c.cm. It is not certain that the skull found by Dr. Hrdlika is that of an Aleut, as the facial bones are missing.

More Radium

Apparatus for radium treatment recently installed at the Hampstead annexe of Westminster Hospital incorporates a new system of distant control for the better protection of operators, and has allowed larger bombs to be used. Additional radium has been acquired to give effect to the conclusion, earlier reached by the surgeons in charge, that deeper penetration can be obtained by removing the radium to a greater distance from the point of application. Four grammes of radium, valued at about £40,000, are used at the annexe and are carried alternately by two bombs. By a system of automatic electric control the radium, in its container, can be lifted from a leaden safe into one of the bombs and swung into position over the patient. The electric switchboard is situated 14 ft. from the patient's couch.

Camera History

Some of the earliest and most important instruments in the history of photography have just been acquired by the Science Museum on loan from The Royal Photographic Society. They include three instruments used by Fox Talbot, the inventor of the first paper photographic process. These are : a camera lucida, the use of which on the shores of Lake Como in 1833 first suggested to him that the invention of a sensitive paper would record such scenes more perfectly than sketches made by hand (this is the instrument mentioned in his " Pencil of Nature," published in 1844) ; Fox Talbot's solar microscope, with which the earliest photomicrographs on paper were produced ; and a Culpepper type microscope, c. 1820.

The Hebrew University in Jerusalem

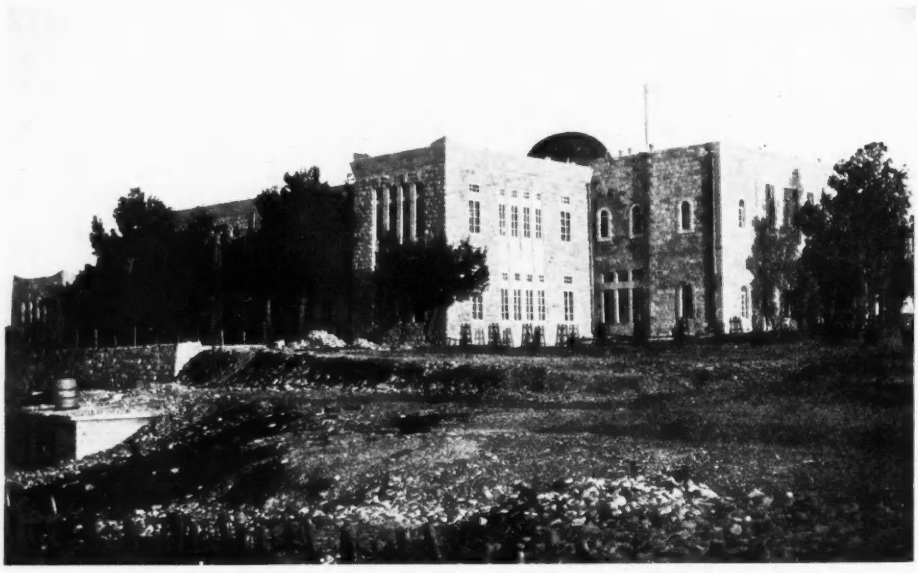
By Lucien Harris, B.A. (Oxon.)

Whatever the fundamental cause of the recent troubles in Palestine, it cannot be alleged that the Jewish community there has neglected the cultural side of the development of the country. The Hebrew University at Jerusalem has a programme, here described, which cannot fail to improve conditions throughout Palestine if the disruptive forces now at work will permit it to be carried out.

IN the newly-developed parts of the world, centres of learning can become very powerful creative and energising forces. The Hebrew University in Jerusalem is playing an increasingly important part in the spiritual and material development of the Near East. Since its inauguration in 1925, it has established for itself a reputation for sound scholarship and research. There are now close upon 600 students, post-graduate and undergraduate, drawn largely from Palestine and Central and Eastern Europe. Admission to the university is upon the basis of a secondary school certificate equivalent to a Continental Lycée or Gymnasium. So far 58 students of the Faculty of Humanities have graduated with the degree of M.A. They have all found employment both in Palestine and abroad, some in the teaching profession, others in public and private institutions. Next year the degree in science will be given for the first time.

The addition to the staff, since 1933, of many distinguished academic exiles from Germany has given a great impetus to the work of the Science Faculties, and in particular, to the fulfilment of a plan for a Post-graduate Medical School. By agreement between the University and the Hadassah Medical Organisation, a University Hospital is to be built on Mount Scopus and a Post-graduate Medical and Research School established. Dr. Bernard Zondek, the gynæcologist, and Dr. Wertheimer, the pathologist, will be members of the staff, and Professor Halberstaedter and Dr. Doljansky respectively will direct the laboratories of Radiobiology and Cellular Physiology. The University has also received a generous contribution from anonymous donors for the promotion of Cancer Research.

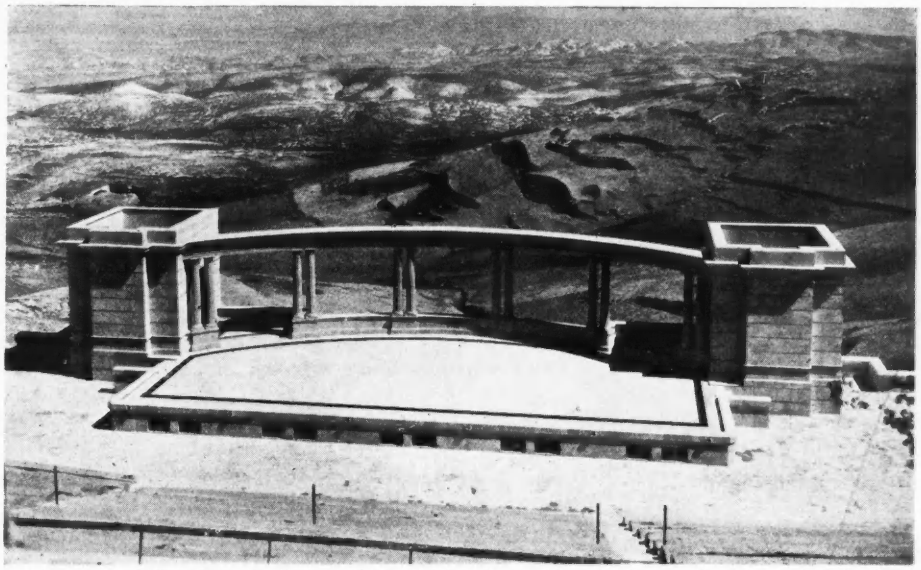
The scientific departments of the University are continually engaged on practical work connected with the general amelioration of Palestine life. The Department of Geology has carried out many hydrographic experiments in connection with water supplies for settlements chiefly in Galilee, and the Judean Hills. Members of the Department of Parasitology spent last summer in Crete investigating sand-fly diseases under the auspices of the Royal Society of Great Britain. Cattle diseases in Palestine settlements were also studied. The Zoology Department undertook work on field-mice extermination, Red Scale, and other agricultural pests. The Department of Hygiene continued to investigate the relationship between climatic factors, nutrition, and susceptibility to disease, as well as methods of immunisation against typhus. The Malaria Station



The Chemistry and Biology Building of the Hebrew University of Jerusalem.

at Rosh Pinah undertook biological investigations of malaria-bearing mosquitoes, and instruction in malariology was given to a number of medical practitioners.

On the Humanities side, the scientific work of the Institute of Oriental Studies progresses favourably. The publication of the works of the Arabic Historian, Baladhuri, and a concordance of classical Arabic poetry is now in hand. The Lord Plumer Arabic scholarship, which is endowed by the British Friends of the Hebrew University, was recently granted for the first time to a graduate of the University.



The stage of the open-air theatre of the University, with a background typical of Palestine, east of Jerusalem.

The University authorities have now drawn up a five-year plan of development which will require a regular income of at least £100,000 a year. This provides for the establishment of a School of Education, a School of Social Studies, a Medical Centre, the extension of the sub-Faculty of Biology into a Faculty of the Natural and Exact Sciences, an Agricultural College to work hand in hand with the Jewish Agency Agricultural Experiment Station at Rehoboth, and also an Engineering School which shall link up with the Haifa Technical College. Institutions such as these are bound in time to have a far-reaching influence on the opening up of Palestine, Transjordan, and the neighbouring lands.

Since 1931, however, owing to the world economic crisis, the American financial support which the University enjoyed has somewhat diminished. A most rigid economy has been observed in administration, and every member of the staff has made a voluntary sacrifice of between one-quarter and one-third of his salary. The accommodation and equipment at present available at the University are lamentably inadequate to cope with the rapid growth of the staff and student body and the general extension of activity. This state of affairs can only be remedied by increased financial support, preferably in the form of substantial endowments similar to those enjoyed by most European and American Universities. It is hardly a good thing that the University should be so largely dependent on philanthropic support from abroad. Now that the Palestine Government is the happy possessor of a £6 million Treasury surplus it will, no doubt, see its way clear towards making far larger grants-in-aid to the Jerusalem University than it has made hitherto.

Books Received.

Stone Age in Africa. By L. S. B. Leakey. (Oxford. 7*s.* 6*d.*)

Television Optics. By L. M Myers (Pitman. 30*s.*)

Literary Originals of Sussex. By G. and R. Thurston Hopkins. (A. J. Philip, Gravesend. 2*s.*)

Cosmic Rays Thus Far. By H. B. Lemon. (Heinemann. 7*s.* 6*d.*)

Through Science to God. By N. A. Smyth. (Macmillan. 10*s.* 6*d.*)

Apes and Monkeys. By E. G. Boulenger. (Harrap. 7*s.*6*d.*)

Earthquakes. By N. H. Heck. (Oxford University Press. 16*s.*)

Nutrition Factors in Disease. By W. H. Fearon. (Heinemann. 7*s.* 6*d.*)

The Emergence of Human Culture. By C. J. Warden. (Macmillan. 8*s.* 6*d.*)

Bird Migration. By A. Landsborough Thomson. (Witherby. 5*s.*)

Art and Life in New Guinea. By R. B. Firth. (Studio Publications. 10*s.* 6*d.*)

Television: Technical Terms and Definitions. By E. J. G. Lewis. (Pitman. 5*s.*)

Food and the Family Budget. (Interim Report of Engineers' Study Group on Economics. 3*s.* 6*d.*)

(*Continued on page* 359)

A Forgotten Harbour

By Cecil W. Knox.

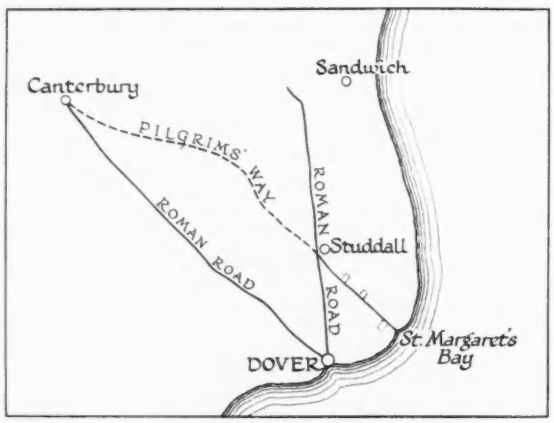
The coastline of England is changing, imperceptibly, every day; and observation of the sum of these changes throws light on the history of past ages. The Kentish coast, facing the continent of Europe, has played as great a part as any in the story of England and we have here a chapter in its history which could not be repeated to-day.

How many dwellers at St. Margaret's Bay realise that their Bay was once a beautiful land-locked harbour and, perhaps, the most important port in Britain?

The evidence for this is seen in the accompanying map-illustration on page 355.

The left-hand picture shows St. Margaret's Bay and the lie of the land for ten miles westward. We see a series of parallel water-worn valleys running N.E. from the high land above the Dour Valley down to sea level in the Stour Valley. The last of this series is St. Margaret's Valley, which starts at the South Foreland lighthouse and, as seen in the central picture, runs steeply down to the shore at St. Margaret's Bay, flanked by cliffs some 200 feet high. Once upon a time the South Foreland extended far out to sea. The last relief-map shows it when it was half-a-mile seaward of its present position. At this time St. Margaret's Valley ran into the sea somewhat as shown. Traces of it can be seen in the 5 and 10 fathom lines on the 1-inch O.S. Map.

We can make a fair guess as to when this was if we consider the following facts:—about 3000 B.C. this



The Roman and pre-Roman roads near St. Margaret's Bay. Note that the Pilgrims' Way from the cross-roads at Studdall to the shore was adopted by the Romans.

corner of England was some 70 feet higher than now, and the Channel did not exist. Then the land began to sink slowly into the sea until about 1600 B.C., when the subsidence ended and the Channel had come into being. As St. Margaret's Valley (which was formed long before 3000 B.C.) sank into the sea it formed this harbour. The fact of this subsidence and its extent (about 70 feet) is beyond dispute, but the date given above may be questioned. The arguments in its favour are well stated by Clement Reid in his *Submerged Forests*. His conclusions are accepted by Cyril Fox in his *Personality of Britain*. Further confirmation is to be found in a remarkable article on Romney Marsh by C. T. Gilbert, in the *Archæologia Cantiana* for 1933.

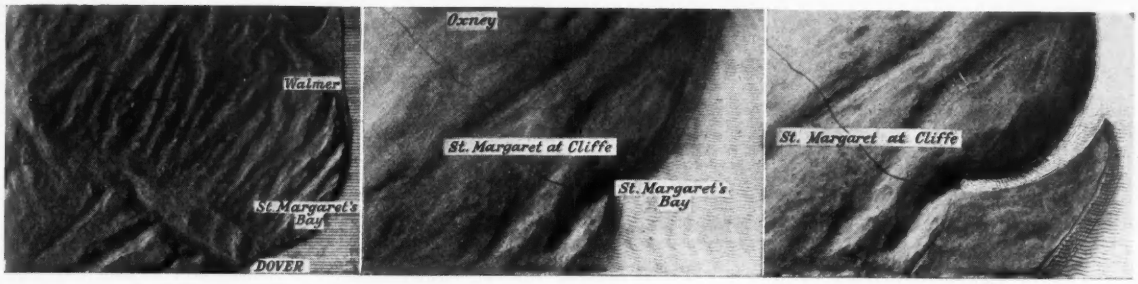
Clement Reid tells us (p. 65) that: "... valleys with their seaward ends submerged and forming harbours are conspicuous in Kent. Owing to local conditions the valleys are mostly narrow and steep, and the small harbours therefore soon filled up, or were lost, through the cutting back of the cliffs on either side. Possibly in Cæsar's day good natural harbours were still in existence here."

This exactly describes the origin and fate of the harbour at St. Margaret's Bay. It began to come into existence about 3000 B.C., and is dying to-day.

If only we knew the rate of coast erosion at the South Foreland we should know the extent of this harbour in Roman times. Unfortunately, we do not know it. Local tradition tells us that before the building of the Admiralty Pier at Dover the erosion of these cliffs was very rapid and a matter of serious concern to the authorities. The pier seems to have diverted the coastal current seawards, and to have stopped excessive erosion. But during the last twelve years there have been three heavy falls of cliff to the north of St. Margaret's, and six inches a year is suggested as the probable rate of erosion at this point. If our data are even approximately correct, this harbour must have been at its prime from about 2000 to 1000 B.C., before much silt had accumulated and before much coast erosion had taken place.

This was the Bronze Age. It seems not unreasonable to suppose that throughout this age our harbour was not less extensive than that shown in our right-hand diagram. A thousand years later—*i.e.*, in Roman times—it had probably contracted to half this length, but had become wider owing to wave erosion, which formed cliffs on both sides.

It is certain that this harbour, facing north-east, would be far preferable to Dover for the primitive craft



Relief diagram of the parallel depressions between the valleys of the Dour and the Stour.

St. Margaret's Bay as it is to-day, showing all that remains of its harbour.

Conjectural restoration of St. Margaret's Harbour before the South Foreland was eroded back to its present position.

of the Bronze Age engaged in cross-channel traffic. The difficulty of entering and leaving Dover harbour, owing to the prevailing south-west winds and the tidal currents, must have made that port almost inaccessible at times. Passengers could have passed on to the Wantsum Channel, and landed at Stourmouth or Upstreet, but why should they when this landing place was available ?

The particular interest of this harbour, however, lies in the fact that it was one of the termini of the Pilgrims' Way : and, owing to its position and safety, probably the most important one. Those who do not already know it should read Mr. Belloc's *The Old Road*. They will then realise what an important part this harbour must have played in the history of Britain. This Pilgrims' Way—as it has come to be called—runs from Salisbury Plain to the S.E. corner of England. It is regarded by many as one of the oldest roads in the world. It was probably in existence before the Recent Subsidence, when the Channel came into being.

Now, the 6-inch Ordnance Survey traces this Way through Canterbury, eastwards, as far as Studdall, on the Roman road from Dover to Wodensborough. Obviously, it could not have stopped here: but, as the continuing length of five miles to the coast is perfectly straight it was not recognised as a part of the Pilgrims' Way. What has happened is evidently this : the road ran to the harbour ; Rome used this road, improved and straightened it, making it part of their system of military roads in this district. The recognition of the existence of this harbour in Roman times opens up a most interesting subject for speculation. If Rice Holmes, in his masterly analysis—" The Place of Cæsar's Landing "—in his *Ancient Britain*, had known of this harbour, he would have rejoiced. Not knowing of it, he says (p. 315) : " The vessels must have been grouped in the bay somewhere between the Castle Cliff and South Foreland." Also, quoting Cæsar, he says : " The formation of the ground was peculiar, the sea being so closely walled in by abrupt heights* that it was possible to throw a missile from the ground above on to the shore." It is obvious that our harbour presents just such an anchorage, especially if we consider that, by Cæsar's time, the sea must have eaten away the sides of the harbour to form precipitous cliffs.

British Industry at Work

The elementary economic principles on which there is little dispute among experts can seldom have been explained more lucidly than by Mr. Geoffrey Crowther in *Ways and Means* (Macmillan. 4s. 6d.). This little book of 200 pages deals with the economic structure of Great Britain to-day, based on up-to-date statistics which are summarised in simple charts.

Beginning with a study of the national income, the author emphasises the complexity of modern trade. The distinction between capital goods and current goods is, of course, one of the most important in the whole of economics, but the remarkable growth in the number of those engaged in " services," now estimated at 40 per cent. of the working population, is not so generally realised.

The author has some hard things to say about our traditional attitude to the export markets, particularly in the heavy trades. We have been too inclined to expect the world to go on wanting our coal, cotton, and steel, instead of supplying the newer and more complicated things such as motor cars, special machinery, artificial silk, and manufactured foodstuffs, for which there is a growing sale overseas. In this connection the interesting fact emerges that the industrialisation of foreign countries, so far from diminishing our potential market, actually increases it. The popular view that foreigners who have acquired their own machinery no longer want to import is disproved by the fact that Germany, the most highly industrialised country in Europe, bought more per head of the population from Great Britain in 1934 than India, a primarily agricultural country.

There seems no doubt that the development of newer industries is vital to the recovery of our distressed areas, which remain the one black spot in the otherwise remarkable position of Great Britain. But every British subject is entitled to take a just pride in the story told by Mr. Crowther, whose *Ways and Means*—available in a half-crown edition for schools, works' libraries, clubs, etc.—deserves the widest possible circulation.

* " . . . *montibus angustis mare continebatur* "

Rail Transport Development in 1936.

By A. P. Le M. Sinkinson.

UNCEASING acceleration, though on a less spectacular scale than in the preceding year, has been the keynote of railway time-tables during 1936. It was scarcely to be expected that a wonderful year such as 1935 would be followed by another equally noteworthy; but the momentum of 1935 has not been wholly lost.

Last year the German State Railways startled the railway world with the introduction of two or three runs booked, start-to-stop, at over 80 miles an hour. These were operated by diesel railcars. This year the U.S.A. has gone one better, with the Super-Chief of the Atchison, Topeka and Santa Fé Railway. This express has a booking between two places, La Junta and Dodge City, in 145 minutes. As they are 202.4 miles apart, this schedule represents a start-to-stop average speed of 83.7 miles an hour. For the moment the Super-Chief becomes the fastest train in the world. In these days, however, that coveted title changes hands with distressing frequency, and while these words are being written some other railway may have annexed the record. The 2,228 miles from Chicago to Los Angeles are covered in 39¾ hours, at an average speed of more than 56 miles an hour.

The make-up of the Super-Chief is interesting. The German railways achieve their ultra-fast bookings by means of diesel units of two or three railcars. The American record-holder is a complete train drawn by a diesel locomotive. Diesel-driven trains of this nature are multiplying in the United States. The Union Pacific RR. has two twelve-car diesel-electric trains, of which the first two coaches are the power cars, each containing a 1,200 b.h.p. engine. These City of Denver trains, as they are called, run the 1,048 miles between Chicago and Denver in 16 hours or less, at a speed throughout of over 65 miles an hour.

Some French Achievements.

On the continent of Europe the Eastern Railway of France operates a non-stop express railcar service between Paris and Nancy, a distance of 219 miles. The time of 3¼ hours in either direction requires an average speed of 67.4 miles an hour. The French State Railways have a number of railcars between Paris and Havre, running the 131.5 miles in either direction in 118 minutes, non-stop at 72 miles an hour, or in 2 hrs. with a stop at Rouen. Some of these cars are fitted with Bugatti-Royal petrol engines. Other Bugatti railcar services on the Etat are between Paris and Cherbourg, Paris and Trouville-Deauville, and Dieppe and Nantes. Similar railcars operate on the P.L.M. between Paris and Lyons.

Railcar speeds in Denmark have been increased, one railcar having a start-to-stop booking over a short distance at 64.7 miles an hour. In Great Britain, apart from the isolated efforts of the Great Western Railway, the railcar seems to languish. In Ireland the Great Northern and the L.M.S. (Northern Counties Committee) have a few railcars for secondary services. They are not expected to travel very fast, but one of the Great Western cars is booked to run 19.6 miles in 18 minutes.

Electric traction has continued to develop. Italy has introduced some high-speed articulated trains of three coaches for service on the electric lines between Bologna, Florence, Rome and Naples. The first of these trains, on its trials, ran the distance of 412 miles in 5 hours 35 minutes, at an average speed of 73.8 miles an hour, and attained a maximum speed of 115 miles an hour. In France the Paris-Orleans-Midi has electrified long sections of its main lines. The Sud Express, now hauled for a considerable portion of its journey by electric locomotives, has been speeded up to cover the 362 miles from Paris to Bordeaux in 5 hours 44 minutes. This entails an average of 63.1 miles an hour, including all stops. The distance of 146.7 miles between Paris (Quai d'Orsay) and Tours (St-Pierre-des-Corps) is covered in 131 minutes at 67.2 miles an hour.

New Triumphs of Steam.

Germany has electric railcars or trains running from Munich to Augsburg, 38.4 miles, in 33 minutes, at 69.8, from Augsburg to Ulm, 52 miles, in 46 minutes, at 67.8, and from Augsburg to Nuremberg, 85.2 miles in 80 minutes, at 63.9 miles an hour. The steam locomotive is not, however, by any means a back number. The feats of its diesel and electric rivals have spurred it on to new triumphs. The L.N.E.R. *Silver Jubilee* express has been marching from victory to victory. On August 27, 1936, *Silver Fox*, one of the streamlined Pacific locomotives detailed to work this train, reached a maximum speed of 113 miles an hour on the down gradient between Stoke Summit and Tallington (Lincs) and ran 16½ miles at an average of 100.2 miles an hour. Still more striking was the uphill work on the return journey to Newcastle, no less than 82.6 miles an hour being averaged up the gradient to Stoke Summit.

The streamlined German 4-6-4 express locomotive, which has reached a momentary maximum of 124 miles an hour with a very light train, is now responsible, with a sister engine, for some fast bookings between Berlin and Hamburg. The *Railway Magazine* for August, 1936, has an account of several remarkable runs on this route. One " FD " train is booked to cover the 178.1 miles from Berlin to Hamburg in 144 minutes, at an average of 74.2, and another from Hamburg to Berlin in 145

minutes, at an average of 73.6 miles an hour. The normal load is only four corridor coaches and a restaurant car, all of comparatively light construction, and the total weight is 207 tons—nearly that of the seven-coach *Silver Jubilee*. The route is absurdly easy. There is only one severe service slack and the gradients are virtually non-existent. Thus, while commending these German high-speed schedules, we should remember that there is no comparable stretch of line in Great Britain so easily graded and so free from speed restrictions.

The Longest Non-Stop Run.

Acceleration of steam-operated trains in Great Britain continues. This summer the non-stop *Flying Scotsman* of the L.N.E.R. was booked to cover the 392.7 miles between King's Cross and Edinburgh in 7¼ hours—an acceleration of 15 minutes on last summer's booking and of no less than one hour on the schedule of five years ago. During the summer also the L.M.S. *Royal Scot* was booked to run from Euston to Glasgow in the unprecedented time of 7½ hours. The L.N.E.R. time to Aberdeen by the *Flying Scotsman* was down to less than 10½ hours. The winter time-tables—operative from the end of September—yield a time of 7 hours 25 minutes to Euston both from Glasgow and from Edinburgh by the up *Royal Scot*. The Glasgow-Euston timing is another new record. The up *Royal Scot* is now booked to cover the 299.1 miles from Carlisle to Euston in 5 hours 21 minutes, at 55.9 miles an hour—the fastest yet. This Carlisle-Euston run is still the world's longest non-stop run for over nine months of the year. The down *Flying Scotsman* now takes only five minutes longer, with four stops, than it did non-stop this summer.

The improvement of railway speed in this country is indicated in an illuminating table published in the *Railway Gazette* for July 31, 1936. In the summer of 1936 the mileage of 60 miles-an-hour trains was 6,206, divided as follows: L.M.S., 2,633; G.W.R., 1,940; L.N.E.R., 1,633; and Southern, *nil*. The total of 6,206 compared with totals of 5,371 in 1935 and of 2,607 in 1934. The fastest train in Great Britain is the *Silver Jubilee* express of the L.N.E.R., though the Great Western still has the fastest start-to-stop schedule. The *Silver Jubilee* train is booked to cover the 232.3 miles between King's Cross and Darlington—and vice versa—in 198 minutes, at 70.4 miles an hour, start-to-stop. The Great Western *Cheltenham Flyer* runs the 77.3 miles from Swindon to Paddington in 65 minutes, at 71.4 miles an hour. The L.N.E.R. *Silver Jubilee* and the Great Western *Bristolian* are still the only two British ultra-fast lightweight expresses. The fastest L.M.S. booking remains at 65.1 miles an hour (Rugby to Watford in 60 minutes).

Correspondence.

ANÆSTHESIA: A PATIENT'S VIEW.

To the Editor of DISCOVERY.

Sir,—As one who has had some personal experience of anæsthesia, both general and local, and has also heard anæsthetics frequently discussed by medical friends and relations as well as by fellow-sufferers, I may perhaps be forgiven for venturing a few remarks strictly from the patient's point of view. I am sure I am not in the least exceptional in considering it most welcome news that we may expect "a notable advance in the knowledge and practice of general anæsthesia." Surely the main object of an anæsthetic is to save the patient suffering and incidentally to facilitate operation. What the patient expects is that he shall not feel pain at the time; that he will not afterwards find himself generally the worse for the anæsthetic; and that he may not be the worse on account of psychological effects. In my own case I have been fully satisfied with only chloroform. I "went off" just as I was beginning to enjoy the smell, and drifted off into a very pleasant sensation of levitation and lightning blue. There was no nervous reaction and no retrospective irritation, not even nausea,—which, by the way, I have never experienced after a *general* anæsthesia, but very badly after narcotics, especially opiates. Is it usual for patients to have colour impression under anæsthetics? Gas gave me the sensation of being plunged into fiery red, and ether one of enveloping blackness. It seems to me that the weak point of all local anæsthetics is that the patient knows what is going on, and his nervous tension is surely not lessened if precautions are taken against his actually watching the operation. Nor does the prospect of a local anæsthetic diminish apprehension—at least, I have noticed it failed to do so—on second occasions! for one thing, it tends to be *so very local*, and if the operation should extend by a hair's breadth beyond its jurisdiction, then—so far as the patient is concerned—it is illusory. I know that that means remissness or incompetence on the part of the operator-anæsthetist. But, unfortunately, it happens fairly often. Besides, it seems so difficult to establish the amount of the dose. Apparently, what suffices to "deaden" one subject is almost without effect in another, and what may suffice as an anæsthetic may be most upsetting to the system. Finally, the effects often take a very long time to wear off, especially in the case of injections—I mean weeks, or even a month or two. Such fellow-sufferers as I have found apprehensive of general anæsthesia, have not been afraid of unconsciousness, but of dying under the anæsthetic. If they could be relieved of that fear, many who now dread general anæsthesia would unquestionably prefer it to local anæsthesia. The exceptions would be those robust natures who "don't mind seeing themselves cut up" and perhaps even have a perverted curiosity to see it done!

Yours faithfully,

A MERE PATIENT.

Philatelists will welcome the appearance of the new edition (1937) of Messrs. Whitfield King's *Standard Catalogue of Postage Stamps*, at the very moderate price of 5s. When it is realised that the total number of stamps included in the Catalogue is 62,155, of which 1,380 have been added since the last edition, the handy size and reasonable price become doubly remarkable.

The Light-Sensitive Cell in Daily Life

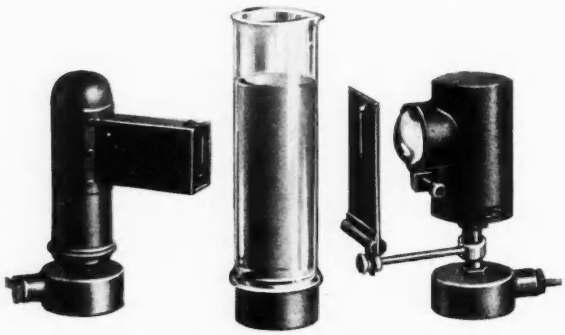
By K. W. Rogers.

Until recently the light-sensitive cell was a scientific wonder. Now its use for guarding the home and for checking industrial processes have been placed on an every-day commercial footing.

Not long ago the light-sensitive cell was a new-born child of the laboratory, uncertain of its powers, asking expert handling. To-day, the use of these cells for controlling street lighting and traffic signs, checking goods on factory conveyors, counting vehicles, timing races, and many other such purposes, is taken for granted even by the man in the street.

There is one thing the man in the street does not realise, however, and that is that he can adapt the cell to his own purposes almost as easily as he now adapts his electric lighting circuit.

Light-actuated apparatus for home use is now on the market. Radiovisor Parent, Ltd., of London, produce a simple light-sensitive bridge, which can be adapted to form a relay for use as a counting unit, or a burglar-alarm ray, among many other things.



The "Radiovisor" turbidity indicator. Right, the projector; left, the receiver.

The principle at the bottom of the apparatus is the Selenium Cell. Selenium is an element which, in one particular form, possesses a peculiar property—a property discovered by accident. This element, while being used as a high resistance in an electrical experiment, was found to vary its resistance to an electric current as the light which shone upon it varied in intensity. The possibilities of this important phenomenon led to experiments with selenium cells, with far-reaching results. But in the early days lack of scientific knowledge, difficulties in manufacture and particularly the absence of the modern valve resulted in the apparatus necessary to utilise the selenium cell being too elaborate and above all too high in price to offer any opportunities to the average man to study and develop its properties.

The Radiovisor bridge, however, is a complete cell, of a handy size and reasonably priced. The resistance variations in the bridge can be amplified by a one-valve circuit in a manner very similar to that of a wireless amplifier. The battery set requires two sources of supply, a low-tension current of 2 volts and a high-tension current of 100-120 volts. The model converted for A.C. operation works in the same manner, the current holding the relay contacts in position being obtained from the transformer, and rectified by the valve. H.T. batteries are retained to supply direct current, but the drain on the battery is very small and its life should be long.

A projector is manufactured for use in conjunction with the bridge. It comprises a standard 4-volt 2-watt motor indicator lamp, screwed into a holder in the centre of a mirror, which throws a concentrated beam on to the cell.

Among industrial appliances of the light-sensitive cell, probably the counting unit has the most numerous possible applications. Apart from the electro-magnetic counter to be operated, the apparatus comprises two units, the projector and the receiver, consisting of similar cast-iron boxes fitted with small windows, each box mounted on a bracket that gives universal movement for setting up and aligning. The projector unit contains a low voltage focusing lamp with lens and focusing arrangement, and a transformer which supplies not only this lamp, but also the filament current for the valve contained in the receiver. The latter contains both the bridge and the valve relay circuit, from which ordinary leads go to the electro-magnetic counter.

As distinct from such commercial apparatus, the Radiovisor bridge set, mentioned above, is essentially designed for the home constructor, and is sold in the form of a construction kit, designated "Raycraft," though a completely assembled A.C. mains model is likewise available. Full details of these and of various kinds of subsidiary apparatus are obtainable from the manufacturers.

Both the "Raycraft" sets and the commercial counting apparatus use a circuit which automatically adapts itself to slow changes in the general illumination, while remaining responsive to the sudden cutting off of

the light which occurs when the ray is broken; hence the apparatus is reasonably free from daylight interference. More complex counting apparatus, including apparatus for scientific and industrial measuring purposes, is also available.

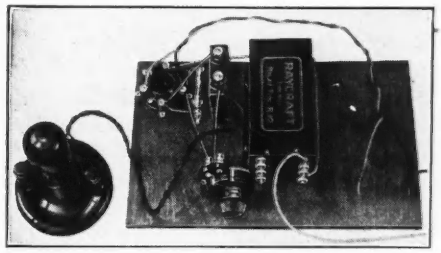
Automatic street lighting is a specialised application, for instance. Street lamps, traffic bollards, and "keep left" signs are automatically lit at night and extinguished in the morning by the varying daylight intensity. They also come into operation if a fog of sufficient density occurs and the road user is provided with light whenever it is required.

Another very useful commercial application is the turbidity indicator. This gives warning when liquid flowing through a pipe begins to run cloudy, and consists of a projector, receiver, and control box. The last contains the valve relay circuit, milliammeter, relay, and adjustable control knobs, by which the warning can be arranged to be given at the required opacity.

Another is a smoke indicator and recorder, working on principles very similar to the above except that the projector and receiver are designed to suit the conditions for such work, including air jet cleaning mechanism to keep the optical system free from soot or dust deposition and other features.

An interesting feature of this apparatus is the measuring circuit, which employs a single standard three electrode valve, whose anode current it is that is registered by the indicators. The circuit has two adjustments, viz.: "set light" and "set dark," each being made by a separate potentiometer, corresponding to the extreme condition of smoke density and to complete absence of smoke. Adjustment is, therefore, a simple matter, and the scale relationship between actual reading and percentage of light obscured is essentially linear over a wide range of light intensity conditions, valve characteristics, and cell constants, so that the readings of all installations are uniform and comparable.

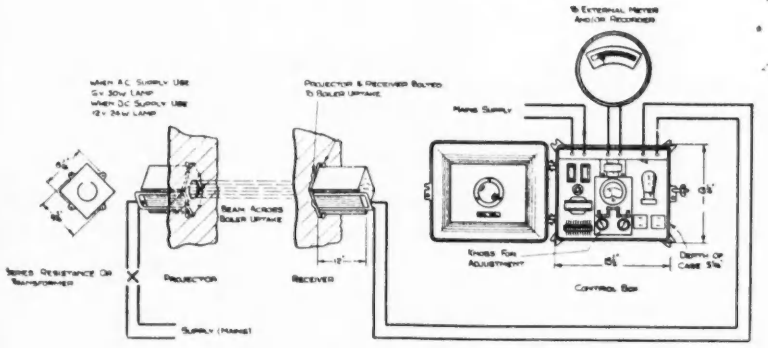
When these settings have been made, all variations such as may occur through the replacement of an expendable part are taken care of, and the reading always returns to the same standard of reference.



The "Raycraft" battery kit wired and assembled.

The indications, therefore, show the actual percentage of light absorbed by the smoke; but for convenience the large indicator is usually calibrated in milliampères, and also carries a Ringelmann scale.

A smoke alarm apparatus for the small industrial chimney is also provided. This equipment differs as regards the projector and receiver units, which are greatly simplified, cleaning being dispensed with. The circuits are, however, similar but modified to operate a relay which can be set to give the alarm each time, and for as long as a predetermined smoke density is exceeded.



The external wiring of a typical smoke indicator installation.

Books Received

(*Continued from page 353*)

Richard Burton, Explorer. By H. J. Schonfield. (Herbert Joseph. 15*s.*)

Slavers of the South Seas. By T. Dunbabin. (Angus & Robertson. 6*s.*)

The Animal's World. By Professor Doris Mackinnon. (Bell. 7*s.* 6*d.*)

Great Scientific Achievements. By Professor A. M. Low. (Nelson. 3*s.* 6*d.*)

The Realm of the Nebulae. By Edwin Hubble. (Oxford University Press. 12*s.* 6*d.*)

Aquariums and Fishponds. By A. Laurence Wells. (Warne. 1*s.* 6*d.*)

Inorganic Chemistry. By Sir Gilbert Morgan and Francis H. Burstall. (Heffer. 15*s.*)

Inheritance and Evolution. By W. F. Wheeler. (Methuen. 3*s.*)

Tools of To-morrow, by J. Norton Leonard, has been republished by Routledge at 5*s.*, and at this price should make a strong appeal to all interested in modern scientific developments.

Book Reviews.

The Future of Africa.

Native Policies in Africa. By DR. L. F. MAIR. (Routledge. 12*s*. 6*d*.).

Ten Africans. Edited by MARGERY PERHAM. (Faber & Faber. 15*s*.).

The future of the indigenous races of Africa is one of the major problems of modern civilisation. Since the period of the 'Partition of Africa' and the redistribution of administrative control after the Great War, Africa has been allowed to work out her destiny with a minimum of outside interference. The Abyssinian adventure is an exception, which, it may be hoped, will not be repeated. It would be an incalculable catastrophe if African territory were once more made a pawn in European politics.

As a result of the absorption of Africa by different European nations and at different periods, there is a wide variation in the policy and methods of governing African peoples. Policy may vary from what can only be termed colonial exploitation to virtual native freedom under the paternal supervision of 'direct rule.' The mandatory system has placed the well-being and training of the native in the foreground and this ideal has undoubtedly affected the general attitude of Powers which once were influenced by less liberal principles.

Recent discussion on the future of the mandated territories has shown the difficulty of bringing home to the public, with whom the ultimate responsibility lies, the essential nature of the problem and its vital importance for the native. Dr. Mair has performed a public service in presenting an admirable survey, which sums up existing conditions, states the policy which determines the administrative attitude towards the native, and explains the details of administrative machinery. Problems are discussed with impartiality, but not without a very distinct point of view. For Dr. Mair, as for everyone who approaches the problem in the spirit of the mandates, it is axiomatic that policy and administrative methods must be framed and tested in the light of scientific study of native institutions as they are, and of an informed judgment as to the probable effect of any given modification of tribal custom and conditions.

If Dr. Mair can tell us all about administrative methods in Africa, Miss Perham's *Ten Africans* enables us to judge them by their product. It is a weakness of sociological method that it can study human nature only in bulk. But these ten autobiographies of Africans bring us into immediate and intimate touch with native life as the experience of an individual. Nor are they random samples. They mount on an ascending scale in the process of adaptation to European contacts.

Miss Perham, beyond adding a few notes for the benefit of those of her readers who are not anthropologists, has left the autobiographies untouched. For the layman these ten lives will prove as interesting and entertaining, as they are valuable for the social anthropologist.

E. N. FALLAIZE.

Sex and Civilisation.

Sacrifice to Attis. By WILLIAM A. BREND, M.D. (Heinemann. 10*s*. 6*d*.).

This is not a very good book, though it deals with a very important subject and contains many sound views and a good deal of interesting detail and quotation. The weakness is that the author has not dealt with his main topic relevantly and consistently and has not resisted the temptation, inevitable in books of this sort, to make one's flesh creep by exciting stories which have no real bearing on the chief concern.

The main new problem which Dr. Brend very properly has in mind, is the falling off of the birth-rate in this country. It is said to be now the lowest in the world, though it has yet not taken effect in reducing the population owing to our constantly increasing care of life.

One cannot help thinking that the habitual pessimists in this matter may easily be mistaken, as they generally are in other matters. Why should we assume that the present tendency to limit families or avoid children is a necessary and unalterable one among us? Dr. Brend speaks somewhere of the possible efficacy of 'heroic' measures, but unfortunately does not tell us what they are or should be. Is it a dictator in this country also that he has in mind? Or would not some more rational method, appealing to the good sense and patriotism which we still possess, be more suitable to our case? Some of us may be inclined to see, in the greater love of the country and the growth of a taste for a simpler life, signs of a move in the right direction. Some remarks of Dr. Brend are quite encouraging, as where he tells us that the bearing of large families is by no means necessarily a bad thing for the mothers. Other statements, *e.g.*, the vague and indiscriminate criticism of 'public schools' as if they were all governed by clerical headmasters with an anti-sex bias, are rather common form in books of this type and irritating rather than enlightening.

F. S. MARVIN.

Human Ecology. By J. W. Bews. With an Introduction by General Rt. Hon. J. C. Smuts, P.C., F.R.S. (Oxford University Press. 15*s*.)

The study of life from the ecological standpoint has received more attention from the observers of plants than of animals, so it is appropriate that this work comes from a botanist. It is significant, too, that it comes from South Africa, where the philosophical study of the intricate and often puzzling problems of the origin of the South African flora has given rise to the line of thought to which we owe this book.

It is of all-embracing appeal, in fact an introduction to the universal study of humanity. For the author regards ecology not as a branch of biology, but rather as an attitude of mind. His main argument is that biologists lose their sense of proportion by over-specialisation, not in the narrowness of the scope of their particular line of research, but in their standpoint. Some confine their attention to the organism, others to its functions, others again to the environment. The truly balanced whole of biology is the triad :—Organism—Function—Environment.

This completeness of aspect, this all-embracing, balanced, and proportionate study of Life is described in General Smuts' word, *holistic*. It is natural that the Principal of a South African college should be under the influence of the author of the philosophy of Holism.

Whatever be his special line of research, any biologist will gain by reading this book, even if he does not always agree with the details. And not only the biologist in the usual sense, for, just as geology merges into history, so in the concluding chapter we pass from ecological biology into sociology ; thence the passage to politics is easy, and to the story of mundane affairs which, after all, are a form of applied biology.

Malcolm Burr.

Tectonic Essays. Mainly Alpine. By E. B. Bailey. (Oxford University Press. 12*s*. 6*d*.)

The title accurately describes this book, in which the author's enthusiasm is constantly visible. The writing is vivid, and there are personal touches that humanise this impressive but difficult subject. Such is the romance of the realisation by Escher von der Linth, as early as 1841, that in the Alps we are in the presence of a majestic phenomenon hitherto undreamt of, of a new kind of structure, mass inversion ; and the impression made on Murchison, who went over the ground with him, and had the grace to recognise the merit of the Swiss but not the vision to apply his methods to Scotland ; we read how Marcel Bertrand, who knew Gosselet's work on the great concealed overthrust of the Franco-Belgian coalfield, elaborated the work of the Swiss geologist, and won fame. What can be the emotion of the layman when the author compares the momentum of the great advancing nappes of the Alps with a Hawaiian surf-rider gliding down the forward slope of a fast travelling wave ?

We read how Schardt, by his *Origine des Préalpes Romandes*, provoked a storm which the author compares with that which raged about another " Origin " ; here, too, arose a champion, Lugeon, who " unveiled the new tectonics to the outside world." The Pre-alps are those familiar mountains which extend from the Arve, past Geneva to Lake Thun ; where we find Trias, Permian and Carboniferous all reposing together *on top of* the Tertiary Flysch. This mass, 120 kilometres long by 40 broad, with a string of giant sentinels rising over 3,000 metres in height, this mass is . . . an erratic, that has travelled from a considerable distance and is, moreover, a mere fragment left by erosion out of a far greater mass.

Such is the romance of geology. Any geologist can read this book with interest and, thanks to the numerous illustrations, follow the reasoning with intelligence, but for proper appreciation an acquaintance with the topography concerned is indispensible. It is a work for specialists to enjoy.

Uffa Fox's Second Book. By Uffa Fox. (Peter Davies. 35*s*.)

The work under review is the second annual of a contemplated series, the first of which was published under the title : *Sailing, Seamanship and Yacht Construction*.

It is the author's good fortune to have practical experience of yacht building, yacht designing and yacht sailing, and his earlier book won very high priase in the British and foreign Press.

It had occurred to the author that yachting, although served by a fairly extensive literature in all its branches, suffered, nevertheless, because the books, and more especially those on the technical side, lagged too far behind latest practice.

That the author had good grounds for his opinion will be gathered from the fact that the volume under review contains 367 pages of type and illustrations, excluding contents list, index, etc., and of these 367 pages, not more than 40 are occupied by matter that is other than very recent, the greatest part of which could not be found elsewhere. The book is especially rich in clear photographs and diagrams (more than 350) which throw much light on the letterpress.

The first part of the book deals with what may be called the " thoroughbred " racing craft, leading off with the largest modern racing cutters, the *J Class*, such as *Endeavour* and *Yankee*, and decreasing step by step in order of size and, also, cost until we come to the International 14-ft. Dinghy Class and the International Canoe Class. These canoes are of skimmer design and attain a speed in smooth water little less than that of a yacht five times their length. It concludes with a chapter on the construction of the masts and the details of rigging adopted for the craft appearing in the preceding chapters. By the way, very much has been accomplished in recent times to bring the hulls of racing yachts up to a high standard of strength and seaworthiness, but the masting and rigging continues to be a somewhat unsatisfactory feature, for the problem of producing strong yet light masts, etc., has not so far been fully solved. The mast of a racing yacht, regarded from an engineering viewpoint, is a " strut " great in length by comparison with its diameter ; moreover, the greater part of the thrust it has to sustain is applied near its upper end and in several non-axial directions while bending loads are applied along its whole length. The chapter is especially valuable, because it shows several ways in which different designers are tackling this outstanding problem.

Part II is mainly historical ; Part III, is solely taken up by power craft ; and Part IV has been written for the yachtsman whose inclinations are for cruising and deep-sea racing, the latter a sport that has advanced by leaps and bounds since the War.

Taking the book as a whole, the general method followed by the author is to describe a yacht representative of each of the racing classes and of each of the several types of cruising and deep-sea racing craft. In all instances the type described represents up-to-date practice.

The author then proceeds to discuss the drawings, not solely as a commentator, but rather as an interpreter, drawing attention

to features that make for speed, an obvious requisite in a racing yacht, and seakindliness, very desirable in a cruiser, for she may have to meet all sorts of seas when on long passages.

Accompanying the above-mentioned drawings, there appears in almost all cases a complete sail and rigging plan. Aerodynamic knowledge is producing changes in the proportions and aspect-ratio of sails, and in spars and rigging, where considerations of wind resistance (*i.e.*, nindrance) are kept well to the forefront.

There is one chapter—*The Designing and Building of Wishbone*—which contains a remarkable amount of detailed information on practical yacht construction.

The author's deep affection for sailing craft finds particular expression in the epilogue, where he considers the problem of designing a great sailing vessel of fore-and-aft rig. And although this chapter is given as a dream, nevertheless, it contains much practical information for those who will try to interpret it.

T. W. MACALPINE.

Muscular Exercise. By GRACE EGGLETON, M.R.C.S., L.R.C.P., M.Sc. (Kegan Paul. 10*s.* 6*d.*)

Exercise affects the entire physiological functioning of the body, and the many changes which follow strenuous exercise are clearly seen in the altered relationship of the blood and its vessels. Dr. Eggleton treats in lucid style and simple language such complex subjects as inhibition, reflex action, hormone activity, etc.

The opening chapters deal with changes in breathing during exercise and it is shown that the oxygen used is taken from the food supply. Later in the work we read that fatigue due to long continued exercise may be combated with suitable doses of sugar. Respiration (which many of us regard as a very simple mechanism) is wonderfully adjusted by means of the carbon dioxide content of the blood. Breathing is controlled by a small nerve-centre in the brain, the cells of which are sensitive to carbon dioxide variation in the fluid which surrounds them. This fluid being in equilibrium with the blood any slight change in the CO_2 pressure of the latter induces the nerve-centre to emit more powerful and more frequent impulses to the chest muscles and diaphragm, thus accelerating respiration.

An effect of muscular exercise is to stimulate the circulation of the blood in a very direct manner, since movement of the muscles works as a return pump forcing blood through the veins and back to the heart. If we " stand at attention " for any long period we become faint owing to the lessened muscular " pumping " action—intermittent " stand easies " relieve this fainting. The contraction of the capillaries even tends to force the blood on its journey on account of the immediate oxygen requirement at all locations.

After treating of the " reflex arc " and such reflexes as the " knee-jerk," Dr. Eggleton goes on to mention how the inception of radio has provided us with sensitive apparatus for " listening in " to muscular movements and the recording of nerve impulses. We then pass to an account of the activity of the hormonic glands in stimulating the body to emotional excitement. Although some have maintained that such periodic outbursts are necessary and that war even is inevitable, the author says that " Man's only claim to civilization, however, is in the increasing use of his powers of reason, and though reason cannot supplant emotion, it can control the method of its expression. . . .Fortunately, the necessity for excitement, combined with activity, can be provided by athletic sports, and this solution has been recognised by many nations." We owe such expressions of emotion in our physiological make-up to adrenalin, the secretion of which is controlled by the sympathetic nerves leading to the adrenal glands. Its effect on the circulation—raising the blood-pressure thereby intensifying the heart's action—is as important in muscular exercise as it is in emotional excitement.

Muscle has two properties—elasticity and viscosity—the former being dependent on the *amount* of change; the latter being proportional to the *rate* of change in the muscle. The theoretical maximum work done may be measured with the " inertia flywheel " depicted in the frontispiece.

The concluding chapter deals with the athlete, and it is of great value to the physical trainer and culturist. Two graphs show the effect of exercise upon the secretion of gastric juice, and what action a digestible and indigestible diet have upon the performance of a cyclist.

This book can be commended to all interested in the working of the human body: there is a refreshing lack of technicalities, yet the matter is well written in an authoritative and masterly fashion. It provides an attractive treatise on body function for the young medical student and teacher of hygiene alike.

FRANK W. BRITTON.

Nodule Implements of the Bournemouth District. By E. HUGH KITCHIN. (Heffer. 4*s.* 6*d.*)

For some years the late Dr. Kitchin was a zealous collector of " nodule " implements, a type which had not hitherto been described. As may be inferred from the name he gave them, they are nodules of flint which afford sufficient evidence of purposive working to justify the conclusion that they are artifacts, but the technique of manufacture is so simple, that they have escaped the notice of previous students of flint industry, and it requires a long apprenticeship and no little faith to recognise them as implements at all. In this treatise, which Dr. Kitchin had prepared at the time of his death, the author describes the circumstances of discovery, discusses flint fracture and the tests of an artefact, indicates the characteristics of the technique of the nodule implement, and illustrates typical specimens. The Bournemouth specimens were found in conditions which give no criterion for dating; but two flints of a similar type were found on the East Coast, which might be contemporary with some of the early implements of " Sub-Crag " dating found by Mr. Reid Moir.

Tissue Culture. By E. N. WILLMER. (Methuen. 4*s.*)
Plant Viruses. By KENNETH M. SMITH. (Methuen. 3*s.* 6*d.*)

There is no more accurate description of the function of the series to which these books belong (Methuen's Monographs on Biological Subjects) than the publishers': " Teachers and students will find up-to-date accounts of their own subjects; research workers, of progress in other departments. The general reader will be able to follow the most recent developments in various branches of biology." These statements are absolutely true; you need only to apply for the list of titles and buy those books which interest you.

Mr. Willmer has divided his book into two sections, the one dealing with unorganised cultures and the unrestrained behaviour of cells, the other with cultures of embryonic organs where the cells co-operate more as they do in the body. His own research

has led him chiefly into the former field (it is a pity he has not included more of his photographs), but he is also well acquainted with the most recent literature of development.

Dr. Smith is concerned with another form of research, also at Cambridge. He is fighting a battle of wits with an enemy, increasingly formidable of recent years—virus diseases in food plants. It is an interesting, and by no means academic, form of applied scientific research, involving co-operation between the entomologist, bacteriologist, plant-breeder and others. Modern transport has swept away yet another of our natural barriers—that against invasion by plant pests. It is just as well, therefore, that in this sphere, at least, there is effective and intelligent work being done all over the world. It is well that such men are actively engaged on our behalf, for increased transport is leading to dangerous upsets in distribution of biological forms, as it is, more obviously, in the political spheres.

Fine-Structure in Line Spectra and Nuclear Spin. By S. Tolansky.
The Quantum Theory of Valency. By W. G. Penney. (Methuen. 3*s*.)

The value of the study of the fine-structure in line spectra is not superficially apparent. It is, however, a very important study for the light it sheds on one of the most intriguing problems of modern physics—the structure of atomic nuclei. The fine-structure of spectral lines frequently arises through the nuclei of the atoms, to which the spectrum is due, having a spin. A study of these spins has told us a great deal about the structure of the nuclei concerned. Considering that there are only just over one hundred pages, the author has packed a tremendous amount of information into the book. It can be recommended to students of physics and physical chemistry who already have some knowledge of the elements of spectroscopy.

The Quantum Theory of Valency is well up to the standard set by the other monographs of this series. The author has had the doubly difficult task of writing in a small compass about a practically new subject—he has had no convenient text-books to boil down. The purpose of the book is "an attempt to explain in simple language the view-point of quantum mechanics on valency and related topics, such as the architecture of molecules and the activation energies of simple reactions."

Paradise Found. By C. Wicksteed Armstrong. (Bale, Sons, and Danielsson. 5*s*.)

Mr. Armstrong presents, in the form of a romance, a new Utopia in the wilds of the Brazilian uplands. In his "Eugenia" many of the problems that vex present civilisation have been solved, stress being laid on the problems arising from the sex-questions and from over-legislation. The Euthanasian gardens provide an answer to another widely-discussed question. Whatever opinions may be held regarding the practices of the Eugenians, Mr. Armstrong is to be thanked for inducing his readers to think out for themselves the solution of urgent sociological problems; though he provides no answer to the question as to how such problems are to be dealt with in a large and populous community. Perhaps, after all, this is unanswerable. A sufficiently interesting story is used on which to thread the various sociological chapters; and the descriptions of the entrance into and escape from this Brazilian paradise are both ingenious and original.

Rural Roundabout. By Hockley Clarke. (Allman and Son. 3*s*. 6*d*.)

The atmosphere of this book breathes the countryside. The author has divided his work into the four seasons, and according to the season so he has painted a word-picture of incidents which happen in a country village. His observation has been very keen, for he tells of things which are sometimes apt to be overlooked. The daily toil of the villagers, too, is not forgotten, for the old lacemakers and the hurdle maker, the shepherd and the rick builder, the last being an artist in hay, are among those which inhabit the old-world village. As to wild life, the author seems to be on very intimate terms with the birds and the animals, for the personal experiences that he gives show his understanding of these creatures. The chapter on the windmill tells of prosperous millers of bygone days, and that on hedgerows shows the skill which the hedger must acquire in order to make this England of ours a green and pleasant land. Altogether, this book is a most refreshing and delightful work; it can be picked up haphazard and the eye will always alight on some chapter which will please. The splendid wood engravings by John J. Dixon give a finishing touch to the book.

Bird Flight. By Gordon C. Aymar. (John Lane. 12*s*. 6*d*.)

This book, written by an American, and now published in England, is "a collection of 200 action photographs," which can only be described as amazing, for they depict the details of the flight of numerous birds with an accuracy which is both instructive and surprising. The accompanying letterpress is divided into four sections: Evolution, Biography, Migration, and Aerodynamics. Of these the last is the most interesting to ornithologists. The upward-and-backward, downward-and-forward wing strokes of gulls, pigeons, duck, doves, and other species, the hovering of humming birds and kingfishers, the gliding of fulmars, albatrosses, and condors are graphically revealed by wonderful photography. The importance of the force of suction on a bird's wing is explained, and the action of the "slotted" wing-tip in eagles, buzzards, and bultures, which has been studied intensively by Lt.-Commander Graham, is described, and illustrated by photographs of these birds in flight. It is instructive to note that even the most advanced photography fails to "stop" the movement of the swiftest fliers. In a photograph of a turnstone, taken at a speed of 1/680 of a second, one wing is indistinct, and in photographs of a humming bird, whose wings are estimated to move at 200 beats a second, and of a swift, which is said to have been timed at 200 miles an hour over a two-mile course, the wings are merely a blur.

Truants By Lord Moynihan, K.C.M.G., C.B. (Cambridge University Press, 3*s*. 6*d*.).

Lord Moynihan was well chosen to deliver a lecture (almost his last work) on such an interesting and varied subject as Medical Truants, and the publishers are much to be congratulated in having produced it in book form at a price to fit the layman's pocket, for whether layman or medical the erudition of the careful and neatly condensed biographies of those men who "deserted Medicine and triumphed," must be of vast interest to all. We should like to have seen the same Merton Hodge, author of *The Wind and the Rain*, mentioned. It is rare nowadays for anyone, even less a doctor, to have the good luck to write a play which had nearly 1,000 performances.

Short Notices.

The Law and the Prophets, No. IX in the Corridors of Time Series (HAROLD PEAKE and H. J. FLEURE; Oxford Univ. Press. 5s.), takes the story of evolution from the revival of the Northern Steppe, by way of the maritime traders of the Great Sea, the philosophies of Israel, Greece, India and China, to the birth of Rome and the Iron Age in the West. It consists of 181 well produced pages, adequately illustrated with photographs, drawings, and maps. This is the concluding volume of the series, which, though appealing most to the non-specialist reader, may yet have something of value for the more serious student of history.

What is this Lourdes? (JOHN GIBBONS; Methuen, 5s.) is a very unusual book. Mr. Gibbons's style, well remembered from *To Italy at Last* and other books, ought to be quite incompatible with a subject such as Lourdes; yet the result of his treatment of it in his usual mundane, modest, almost disillusioned manner is to carry great conviction. Protestants, atheists, and unbelievers generally will gain in respect for Roman Catholicism by reading this book, though they may not gain much in understanding. The actual organisation at Lourdes, however, is very clearly set out, for the author himself acted as a stretcher-bearer there for some time.

Leadership or Domination (PAUL PIGORS; Harrap, 8s. 6d.) is a pioneer book in the sense that it analyses on a practical basis the qualities that make some men leaders and others "leaners." It runs to over three hundred pages, and has a very full bibliography. Dr. Pigors is an American, and the American psychology is dealt with, though this is a very slight detraction. The typography and style of the book, however, may displease many.

Practical Stereoscopic Photography (J. M. DALZELL; Technical Press, 10s. 6d.) is that rare thing, nowadays, a book on photography without any photographs. It suffers little from the lack, for it is essentially a practical book, covering the art in all its branches, and concluding with a chapter on "Movies of Tomorrow." Mr. W. L. F. Wastell, Past President of the Royal Photographic Society, contributes a foreword.

Geometrical Optics (H. T. FLINT; Methuen, 7s. 6d.) is as neat and well set out a work as the author's recent *Wave Mechanics*, and incorporates some of the suggestions of the Physical Society's report on the teaching of Geometrical Optics. It should present no difficulty to students having an adequate knowledge of trigonometry.

The Foundation of Provincial Medical Education in England (E. M. BROCKBANK; Manchester University, 8s. 6d.) gives in more detail than hitherto an account of the origin and history of the Manchester School of Medicine. The information contained in its 187 pages is, however, of general interest, and the sixteen photographs included make it the more valuable.

The Sergeants of the Peace in Medieval England and Wales (R. STEWART-BROWN; Manchester University, 10s. 6d.) is a very informative book of 104 pages, with 34 pages of appendices, dealing with the origins and functions of these particular peace officers. In the first chapter a detailed account is given of the organisation of the sergeants of the peace in Cheshire, and thereafter similar organisations elsewhere are dealt with. Features of the system are discussed in a long, final chapter. *The Medieval English Borough* (JAMES TAIT; Manchester University, 17s. 6d.) is also a closely-written and authoritative work. Mr. Tait, who is Honorary Professor at Manchester University, writes, "this book makes no claim to be the long overdue history of the English borough in the Middle Ages." He refers to it as a study of the origins and constitutional history. It is, however, an amply-annotated history of some 360 pages, and there cannot be much that the author has omitted. The large bibliography is a valuable feature

An Introduction to Neon Lighting (JAMES ORR and A. W. FORREST; Blackie, 3s. 6d.) consists of a detailed description of the manufacture, erection, and maintenance of all neon tubes for advertising and display purposes, and though primarily a practical handbook, can be read with interest by those anxious to keep abreast of the times.

The Electrical Handicraftsman and Experimenter's Manual (H. R. LANGMAN and J. H. MOORE; The Technical Press, 7s. 6d.) is a typical example of that much-used word "vademecum." Though it may hold little for the theorist, its 190 pages, well illustrated with sketches, will be a mine of information for those who are only happy when surrounded by tangled wires, ammeters, condensers, and the like.

Food Values (MARGARET MCKILLOP; Routledge, 3s. 6d.) contains 150 pages of text, interspersed with tables, dealing in detail with the calorific, protein, and other values of our food. This book will disappoint the food faddist. He hopes to be told, uncompromisingly, what he must or must not eat. Miss McKillop is too wise for that, and makes no controversial statements, even in the case of bread.

Exploring the Stratosphere (GERALD HEARD; Nelson, 3s. 6d.) appears at a time when things stratospheric are much in the public mind, and is a simple account of progress made rather than a scientific treatment of theory. The long chapter on "The Uses of the Stratosphere" touches on the future, and should stir the imagination of every reader.

Matteo Ricci's Scientific Contribution to China (HENRI BERNARD, translated by E. C. Werner; Veitch, Peiping, 7s. 6d.) is a closely-written account of the life and work of a man who three hundred years ago brought the first news of European scientific progress to China. Matteo Ricci was a pupil of the great German Jesuit, Christopher Clavius, and this history of scientific interchange between East and West makes very interesting reading. It is of interest to note that the library of the old Jesuits of China, still existing at Peiping, contains a book of Clavius with an inscription to Ricci.

Life of a Scottish Naturalist (*Thomas Edward*), (SAMUEL SMILES; Dent, 3s. 6d.), is an abridgment of this well-known book in the Open Air Library, with a Foreword and wood-cuts by Mr. E. Fitch Daglish, the Editor of the series. Edward's courageous struggle against poverty, ill-health and discouragement makes an amazing story of pluck and pertinacity. He was perhaps the first working-man Naturalist.

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